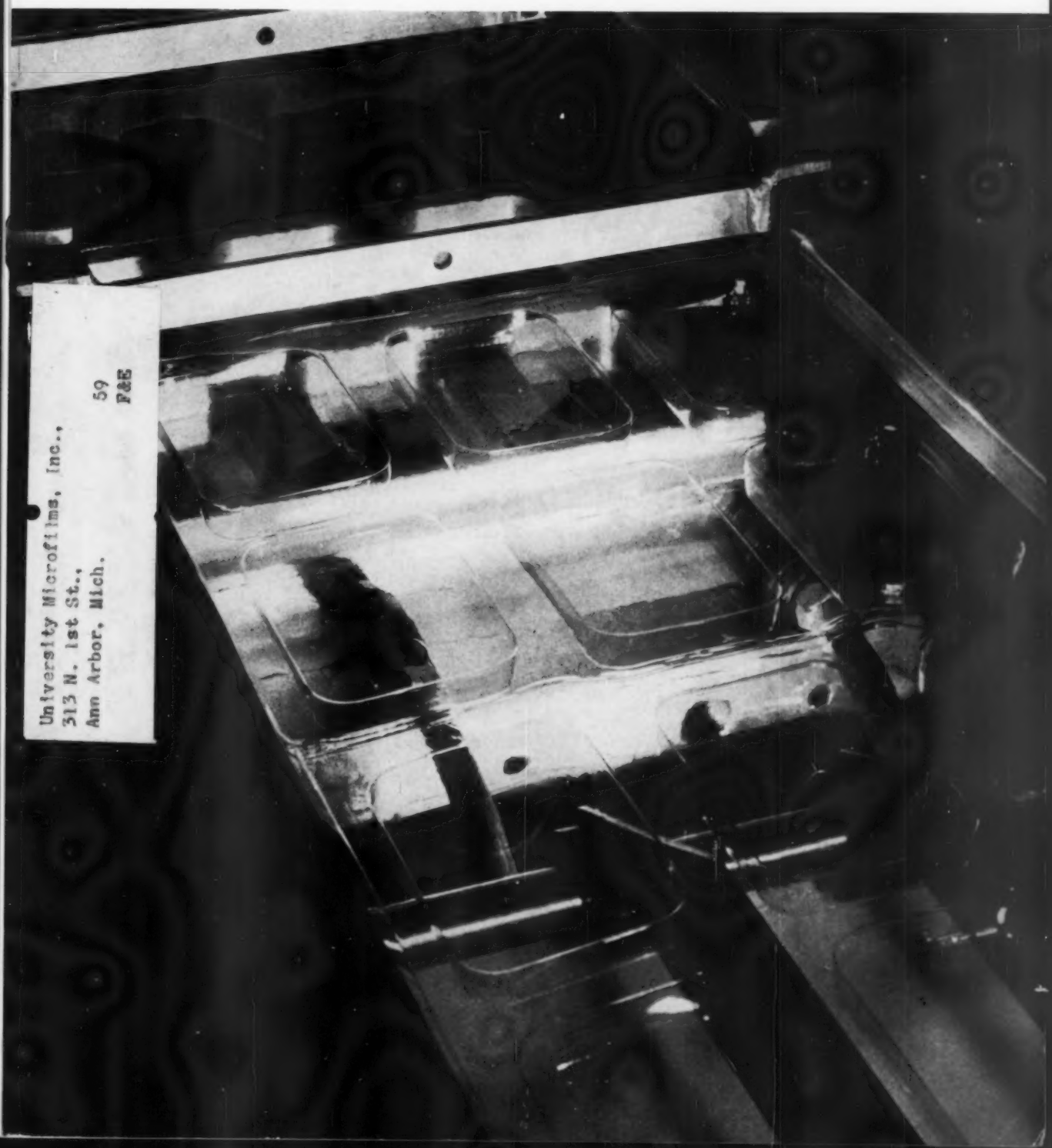
PLASTICS TECHNOLOGY

MARCH 1961

THE MAGAZINE OF APPLIED ENGINEERING



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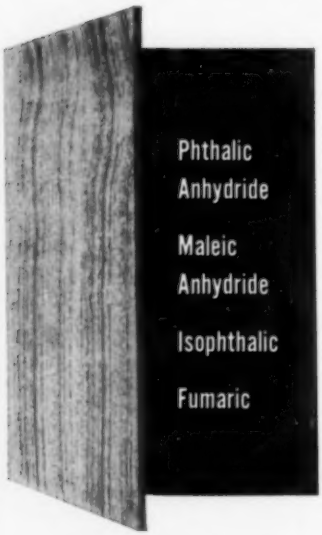

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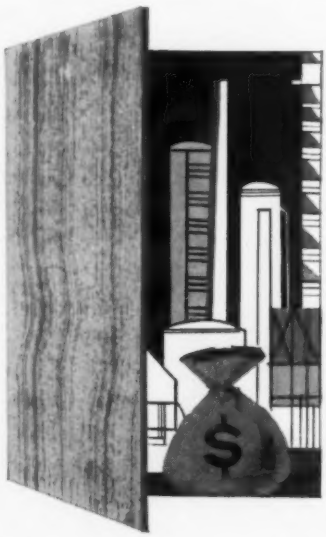

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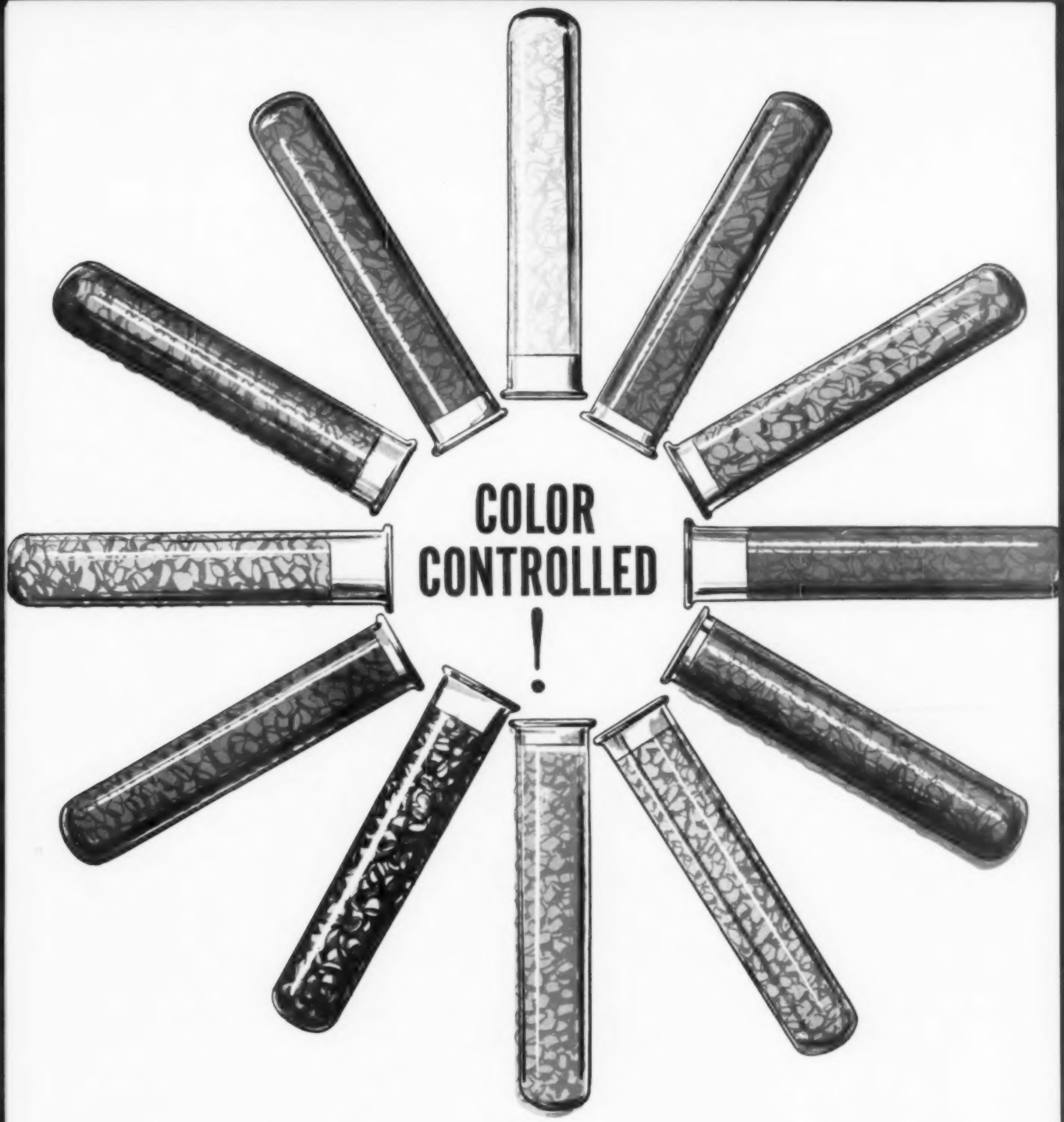

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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

March 1961, Vol. 7, No. 3

feature articles:

low/no pressure fabrication of silicone laminates ..... p. 35
by D. T. RETFORD, M. E. NELSON and K. R. HOFFMAN
Two laminating resins are described; both of which cure by an addition reaction. This means they do not give off water vapor and, therefore, require little or no pressure for cure. Physical and electrical properties of the finished laminates are listed.

abrasion and wear resistance of reinforced polyester surfaces ..... p. 39
by C. B. SIAS
The problem involved was to produce the best possible school-desk top using a polyester molding process. Results of extensive testing are reported and certain conclusions drawn. Conclusions taken from a "proof" experiment are particularly revealing.

wollastonite—an extender for polystyrene ..... p. 49
by PETER VIRTUE
Unlike other pigment-fillers, wollastonite can be added to polystyrene in amounts up to 30% by weight (the others degrade physical properties in amounts over 3%). This, naturally, brings down the price of a highly competitive material.

four epoxy plasticizers ..... p. 51
by E. W. LINES
Compatibility, analysis, and performance properties for the plasticizers are given. Three are secondary, one is primary.

exploring fabrication techniques:

ultrasonic sealing ..... p. 58
by L. J. ZUKOR

feature story:

blister packaging carried into the home ..... p. 56

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Eastman Chemical Products, Inc.

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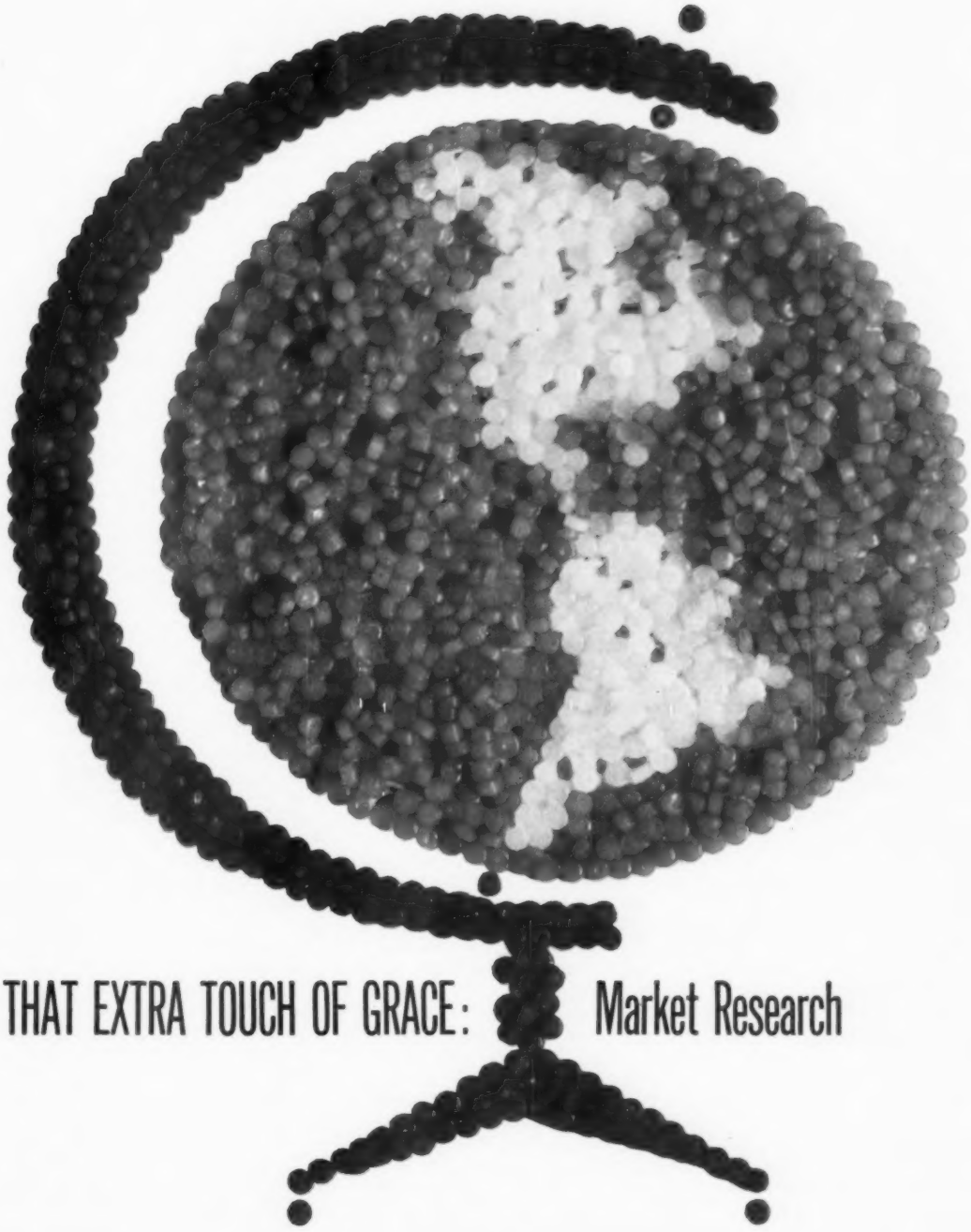

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Letters to the Editor

Sirs:

Re: "Markets for Flexible Foams."

Market research articles of this type are valuable reading for anyone who has dealings in the urethane foam industry. With the present day market set-up, where marketing people often take the initiative in suggesting new products or modifications of existing ones, articles of this type are a must. On the other hand, research and design people will often pick up ideas from a survey which they can incorporate into their own work.

In contrast to other materials, plastics have generally been characterized by falling prices. Some of them, in fact, have gone so low that material suppliers are realizing they cannot continue research and improvements unless the prices are raised. However, if the urethane materials continue to decrease in price, their competitive advantage will be increased accordingly. Admittedly there is a lot of waste in some designs, but if the material itself sells economically, cuttings and odd pieces can be afforded. Further, in the urethane industry, it is the cost of the raw materials which has been falling. Unlike the situation in the styrene industry, for example, this is not impetuous price cutting at the expense of quality.

The urethane market does need some standards, though. With every new material some time must elapse between the first commercial appearance and final product stabilization. This is a problem for the raw material suppliers and urethane foam processors to work out cooperatively.

Plastics in many industries are still being looked upon as substitutes for other materials. Fortunately, many industrial and product designers have come to realize that plastics have certain inate physical characteristics which can be used in products formerly though impractical or impossible. It seems to me that in finding areas of application which did not previously exist, i.e., in developing new markets instead of trying to take over old ones, urethanes will realize their full potential.

Name Withheld
Chicago, Ill.

Classified comments

Sirs:

We have read the January issue with interest and think you have done an excellent job.

Vito A. Tanzi, President
Air-O-Flow Industries, Inc.
New York 13, N. Y.

Sirs:

We have two corrections and one suggested addition to your Classified List of Auxiliary Equipment for Thermoforming and Compression and/or Transfer Molding which appeared in the January 1961 issue.

Please correct the addresses for the following:

Mold chillers, preheating equipment, pulverizing units—The Rainville Co., Inc., 839 Stewart Ave., Garden City, N. Y.

Tumbling machines — Rainco Mfg. Co., Inc., 501 Third St., P. O. Box 788, Franklin, Pa.

The following could be added to the section on molds: Shaw Industries, Inc., P. O. Box 591, Franklin, Pa.

Thank you.

Harvey H. Mitchell
Reib Associates
Franklin, Pa.

Sirs:

Congratulations on your editorial in the January issue of PLASTICS TECHNOLOGY, as you have very succinctly described one of the major ills facing the plastics industry today! A solution to this problem is indeed the responsibility of all concerned, but your publication can take a significant step in this direction by continuing to publish articles examining in depth specific process areas, such as your articles on extrusion and blow molding. These articles, together with equally important market surveys such as your recent evaluation of the flexible foam area, will bring much needed light into areas where only a general knowledge can sometimes lead to the problems that were discussed in your editorial.

Keep up the good work.

Jack W. Little
Emery Industries, Inc.
Cincinnati 2, O.

(Thank you. We shall certainly keep trying.—Ed.)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

On schedule

In the past, this column has restricted itself to listing the title, author, and a brief description of the articles which were tentatively scheduled for appearance the following month. We would like to depart from this format so that we can let you know a little more about our future plans for editorial coverage.

Timeliness and length can cause a shifting of articles from one month to another, and a looked-for article may not appear the month it was scheduled. We also hope to expand our range of subjects by going in for more staff-written material. Sources will be credited, of course.

Some of this planning is more "long-range" than short and, as they occur, let us know whether you approve or not. Nothing in life is static except static electricity, and we earnestly hope that we will never become "set in our ways."

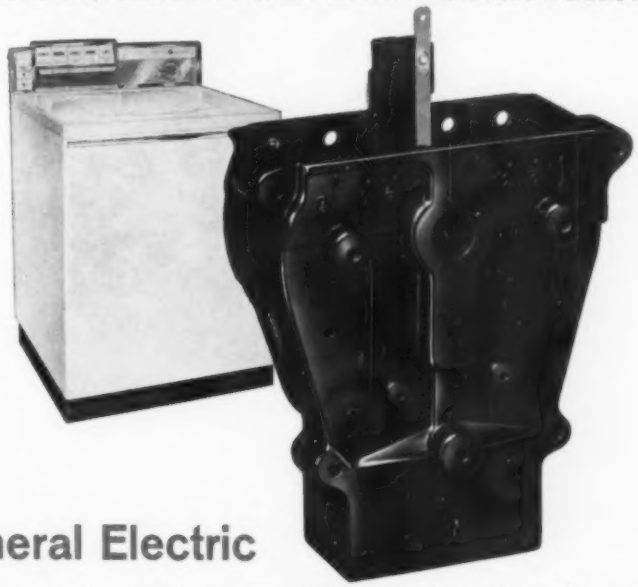
Next month we will definitely carry an article by Dr. B. Baum and Mrs. A. L. Perun of Union Carbide Plastics Co., on the subject of stabilizer efficiency. It will cover methods for determining same: oxygen bomb Vs oven heating Vs milling. All give valid results.

Bob Morrison of the Molded Fiber Glass Companies will describe his RECO operation. This company was set up to take care of his research and testing needs which he feels are necessary at the molder level.

Another April article comes from Mr. C. Wibbens of Hercules Powder Co., covering his studies on the "Chill-Roll Casting of Polypropylene Film." For May, we have an Ankerwerk article on the "Single Screw Injection Machine" by Dr. Frimberger and J. Fuller.

Other articles on tap include a staff-written story on pneumatic conveying, another on mixing resin, glass, and filler. We have a report by Ren Morse on management considerations in the operation of captive injection molding installations. We have an Engineering Forum article by Paul Fina on continuing one's education in plastics, and an article on "Shrinkage of Glass-Reinforced Polyesters."

IF PHENOLICS CAN DO IT, PLENCO CAN PROVIDE IT-AND DOES-FOR GENERAL ELECTRIC



General Electric

solves a housing problem with the help of

PLENCO

PHENOLIC MOLDING COMPOUNDS

Minding the wash from start to finish is the job of the timer. To do a good job of control, it must be well protected—against heat, moisture, vibration, impact.

The right housing is the answer. *And* the right molding material; the General Electric Company, Major Appliance Division, Louisville, Kentucky, found it with Plenco 466 H.R. Black, a special-purpose phenolic compound formulated for excellent resistance to heat and for extra durability.

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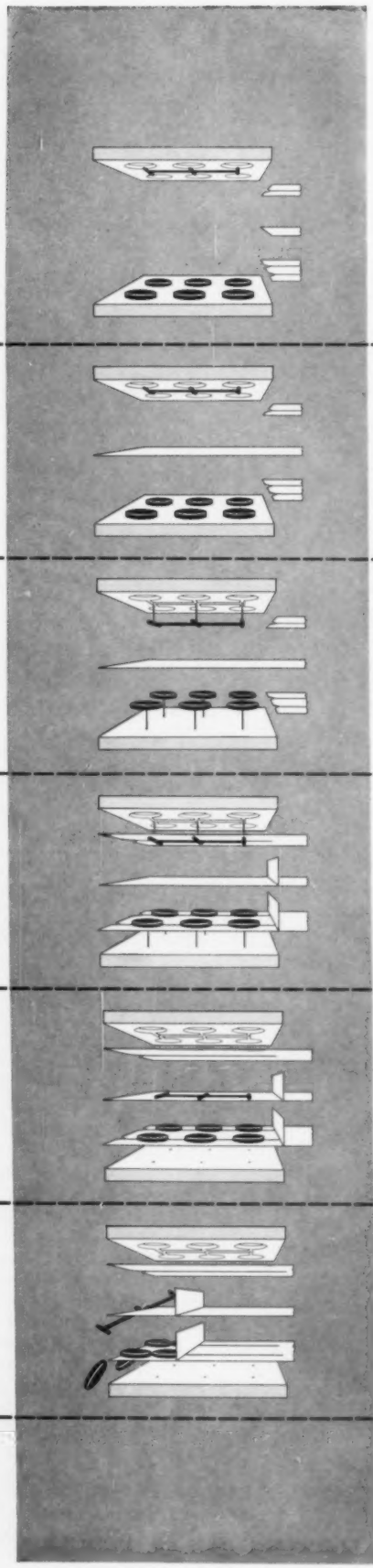


1. Press opens with molded parts positively retained in the lower die and the runner system in the upper die . . . thus accomplishing degating.

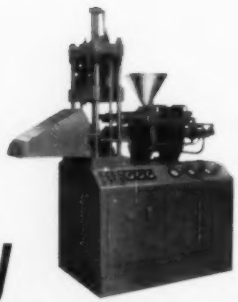
2. Separator plate moves forward under runner system.

3. Knock-out pins eject the parts and runner system.

4. Separate slotted combs for parts and runners move forward into stripping position.

5. Ejector pins are retracted, stripping parts and runner system. Parts remain on lower comb and runner system falls on separator plate.

6. Wipers assure controlled removal of parts from comb and runners from separator plate into separate chutes.



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All machines illustrated here in stock for

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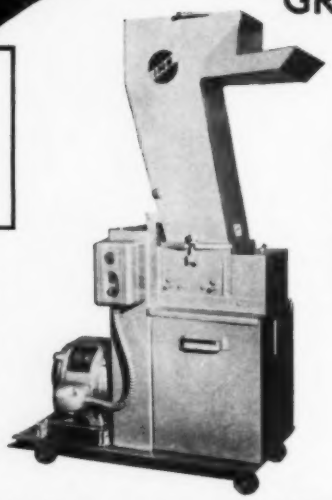

The IMS M-3 6½" x 7" throat sprue grinder — rugged — simple in design — easiest to clean — built-in throat clearance bar — casters — catch pan.

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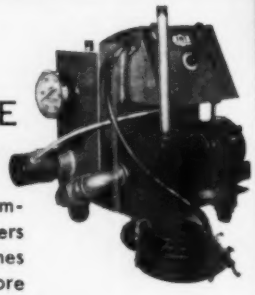

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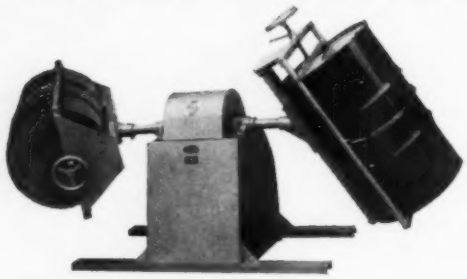

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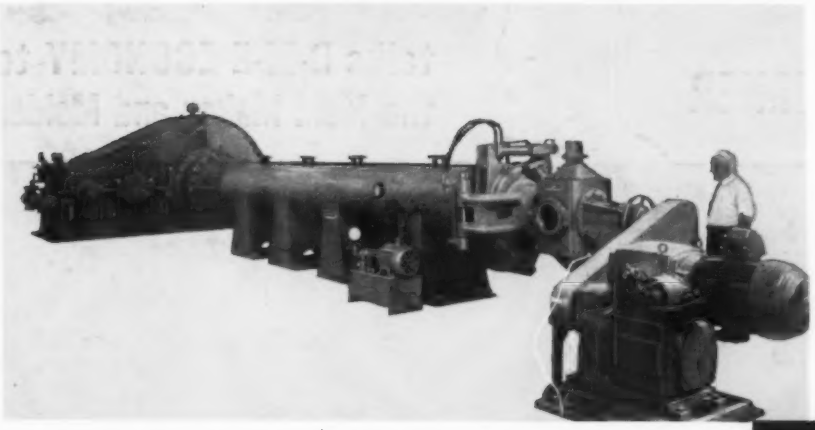
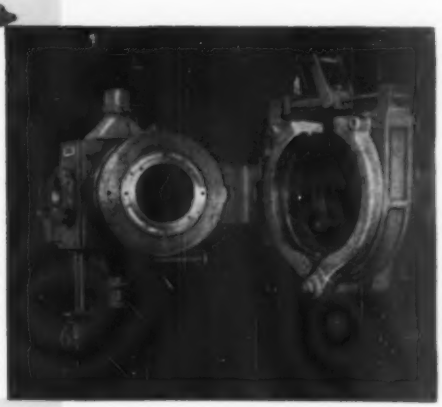


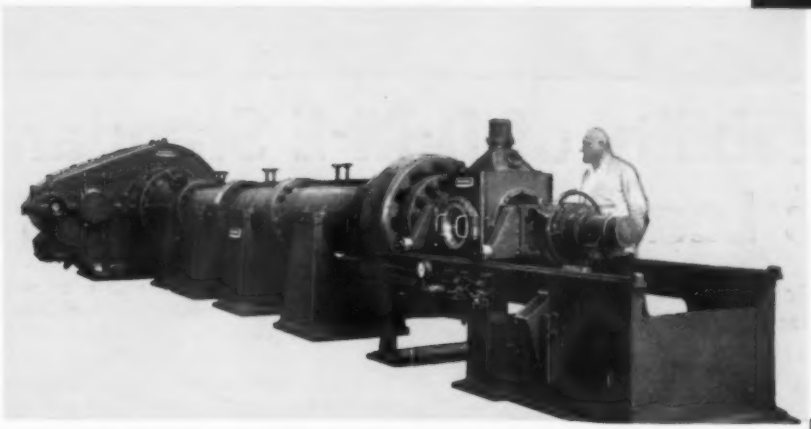
The machine at left is one of the largest underwater pelletizers ever built. Equipped with a 15" screw that is 30' long, it is driven by a 2000-hp motor and is designed for 10,000-psi working pressure. The head (shown open in the illustration below) is equipped with a hydraulic-clamp locking device.

Two examples of

underwater pelletizers

developed by Farrel for high-capacity extrusion





This cold-feed polyethylene extruder is driven by a 1500-hp motor and Dynamatic drive with a top speed of 100 rpm. Designed for head pressures of 10,000 psi, it is equipped with a long throttling ring. The head is mounted on rails so that after unlocking it can be quickly withdrawn.

FARREL®

Among Farrel's important contributions in the field of plastics processing has been the development of underwater pelletizers. While the two examples given are high-capacity machines, smaller extruders with underwater heads are also available.

These pelletizers are designed for the continuous working of plastics, operating as cold-feed machines or handling material direct from a Banbury® mixer or reactor. After working, the material is forced through a straining screen and then pelletized in an underwater head. Water is circulated through the head to separate the pellets and convey them to the cooling unit.

If you are interested, why not discuss this development with a Farrel engineer?

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.

Sales Offices: Ansonia, Buffalo, Akron, Chicago, Los Angeles, Houston, Atlanta

European Office: Piazza della Republica 32, Milano, Italy FB-1211

Why the MOLD DESIGNER

talks D-M-E ECONOMY to the Mold Maker and Molder

Interchangeability of D-M-E Standard Mold Bases Leads to Extra Savings!

Specifying D-M-E Standard Mold Bases and component parts reduces mold cost, saves time, and provides an unlimited variety of plastic mold assemblies.

D-M-E standard components are fully interchangeable: Replacements can be made without special fitting or reworking. Cavity plates and components can easily and quickly be removed and replaced in perfect alignment.

Whether for injection or compression molding, D-M-E Standard Mold Bases enable you to work with greater flexibility by providing a selection of over 7,000 cataloged mold base combinations! And D-M-E Master Layouts enable designers to devote more time to cavity layout.

MOLD MAKER: D-M-E first-quality carbon or alloy steel assures easier and more reliable machining. And D-M-E Standard Mold Bases have exclusive built-in features at standard cost: surfaces ground flat and square; patented tubular dowels; one-piece ejector housing; stop pins welded to ejector plate; 33 sizes from 9⅞" x 8" to 23¾" x 35½".

MOLDER: D-M-E Standard Mold Bases and components reduce maintenance. They are carried *in stock* at your local D-M-E Branch ready for quick delivery. You eliminate waiting, cut downtime, reduce your inventory and maintain production schedules. With D-M-E you get supplies when you need them from a single reliable source!

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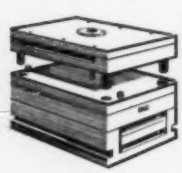
Write today for your 242-page D-M-E Catalog of Standard Mold Bases and Mold Makers' Supplies. No cost, no obligation.

61-A-P



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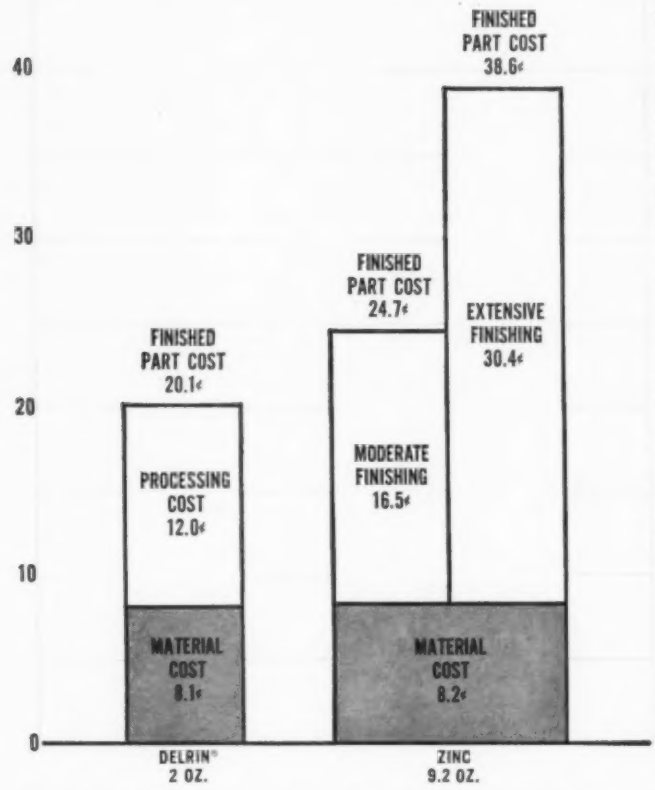
PLASTICS PROSPECTS

New low price for DELRIN® gives molders an additional advantage in metals markets



Comparison of finished-part cost and all component costs of a part made in DELRIN and die-cast zinc is shown above. Note lower raw-material costs of DELRIN (8.1¢ vs. 8.2¢) and wide difference in total finished-part costs when zinc part requires moderate or extensive finishing (20.1¢ vs. 24.7¢ and 38.6¢)—dramatic proof of your strong competitive position with DELRIN in metals-replacement market today!

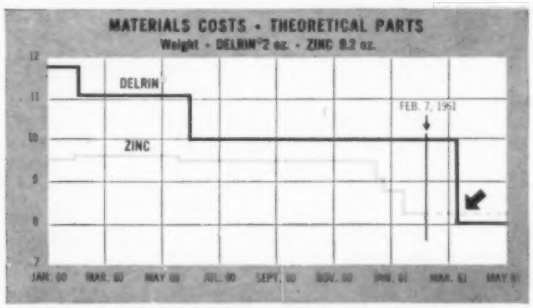
For full information about properties, molding characteristics and applications of DELRIN write: E. I. du Pont de Nemours & Co. (Inc.), Dept. PT-3, Room 2507D, Nemours Building, Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Limited, P.O. Box 660, Montreal, Que.

POLYCHEMICALS DEPARTMENT

65¢-per-lb. price permits lower materials cost than zinc on an equivalent volume basis—plus usual high savings in fabrication costs

On February 7, 1961, Du Pont announced the price reduction of DELRIN acetal resins by 15¢ per lb., from 80¢ to 65¢, creating an unprecedented sales opportunity for you in industries that use metal in cast or molded form. For the first time, DELRIN gives you an advantage over zinc on a *raw-materials-cost* basis for an equivalent part! The new price was effective March 7.

Naturally, your cost advantage becomes even greater on a finished-part basis. When either moderate or extensive finishing operations are required for parts of zinc or aluminum, parts of DELRIN can be made for substantially less (see chart left). Result: Whenever the properties of DELRIN fit the application, you have a sharp sales edge in bidding against any zinc or aluminum die casting that requires finishing, and almost all do. The properties of DELRIN are right for a large segment of applications now being made of die-cast metals.



Cost reductions of zinc and DELRIN announced between January 1, 1960, and February 7, 1961, are reflected in this chart. It shows raw-material costs for a theoretical part requiring 2 oz. DELRIN or 9.2 oz. zinc. Note breakthrough point in March.

This cost reduction for DELRIN is consistent with Du Pont's policy of lowering the prices of its versatile engineering materials whenever possible to help you expand your business. This trend in pricing is expected to continue.

Du Pont's problem-solving engineering materials:

ALATHON® polyethylene resins **DELRIN®** acetal resins **LUCITE®** acrylic resins **ZYTEL®** nylon resins

What's new in processing

A procedure for producing washaway mandrels up to 36 inches in diameter for pressure vessel fabrication with reinforced plastic has been developed by Rezolin, Inc., Santa Monica, Calif. Hot melt, water soluble Paraplast material is slush molded in laminated epoxy molds. The completed hollow mandrel has a uniform wall thickness and a hard, ceramic-like surface that will withstand compressive forces of up to 19,000 psi. After filament winding or laminating and curing of the pressure vessel, the mandrel is washed out.

A new sander uses a red plastic extrusion as the backing block for sandpaper and Dragon Skin. The "E" extrusion is undercut at both ends with a milling machine. The angular undercut flanges hold the backing block in the frame, a vise-type metal bracket which clamps the sandpaper securely in place. According to Anchor Plastics Co., since only a limited number of items were needed, an extruded, fabricated part was more economical than a molded part for this application. The cost of tooling was less than $250.00; an equivalent injection mold would have cost about ten times that amount.

Celanese Chemical Co. will produce acetyls from a process it has licensed from Aldehyd GMBH. The process involves the combination of oxygen with ethylene gas in the presence of a catalyst. The principal product made by the process at the Bay City, Tex., plant soon to be constructed will be acetaldehyde. Manufacture of 2-ethyl hexanol, used in preparation of vinyl resins, will be transferred to Bay City from the Bishop, Tex., facility.

Abstracts

"On Grinding and Polishing Plastics and Lacquers" by W. Burkart and O. Schmid, Kunststoff-Rundschau, September 1960, discusses procedures for surface finishing, with emphasis on perfect finishes.

"Bright Future for Extrusion Coating" by F. Gebert, Plastverarbeiter, September 1960, reviews the development of extrusion coating and its economic importance. Techniques, equipment, and patents are discussed in the remainder of the article.

"Vacuum Forming of Extruded, Modified Polystyrene Sheets," by W. Neitzert, Plastverarbeiter, September 1960, starts with the extrusion of the modified polystyrene and goes on to the conditions for successful automatic vacuum forming. Advantages of negative and positive forming are compared.

Patents

2,903,389 to Toshitsune Fujita, Tokyo, Japan. A method of molding reinforced plastics in which a monomeric vinyl is introduced into a mold packed with glass fibers. The vinyl, which has removed all air, is in turn driven off by an unsaturated polyester resin driven into the mold under pressure.

2,913,768 to American Can Co. A method of printing and forming oval containers with heads. A flexible tube is printed while on a cylindrical mandrel, then transferred to an oval mandrel for shaping.

2,910,730 to Pittsburgh plate Glass Co. Filling elongated cavities with polyurethane foams. The hydroxyl-isocyanate mixture is placed on a strip of sheet material as long as the tube to be filled. It is moved into the hollow member, which the mixture fills by transverse expansion.

OPTICAL ENGINEERING DESIGN USING CRYSTAL CLEAR ZERLON

In designing plastic objects whose primary function is the refraction or transmission of visible light, refractive index of the plastic is an invaluable tool in engineering design. Refractive index of any material is, of course, the ratio of the velocity of light in a vacuum to the velocity of light in the material in question. That is,

$$n = \frac{\text{Velocity of light in vacuum}}{\text{Velocity of light in material}}$$

While refractive index is normally used for identification and quality control of plastics, it may also be applied as design data for engineering purposes.

Obviously, light which strikes a highly transparent plastic normal to the surface (at a right angle), will pass through without deviation (Fig. 1a). As the plastic is tipped (Fig. 1b) the transmitted ray is refracted ("bent") as it leaves the plastic-air interface.

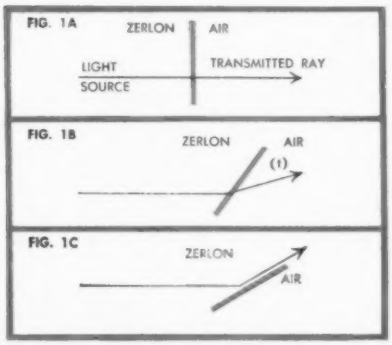


Fig. 1a—Light ray normal to surface.
Fig. 1b—Light ray striking surface obliquely.
Fig. 1c—At critical angle, light is reflected back into the plastic.

As the incident angle is further decreased, an angle is reached at which the ray will not pass into the air, but instead will be reflected into the plastic ("piping" action). (Fig. 1c). This is the critical angle. The critical angle is the incident angle whose sine is the refractive index of air divided by the refractive index of the material in question.

Consider this problem (Fig. 2): to design a radio dial face using Zerlon® crystal-clear, non-yellowing Dow molding plastic. The dial will be illuminated uniformly by interior light, i.e., light "piped" through the dial face from a concealed source. The dial thickness must be sufficient to withstand normal use, but can be *no greater than* 0.115".

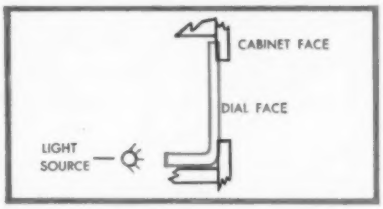
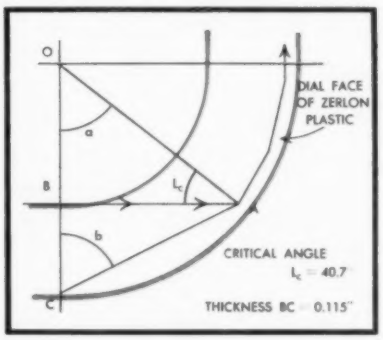


Fig. 2—Design problem.

Light from the source must strike the bend in the dial molding at greater than the critical angle in order to be "piped" along the dial face. For this problem, Zerlon was chosen because of toughness, easy moldability, and transparency. Since the refractive index of Zerlon is 1.533, its critical angle is 40.7° (Sine $L_c = \frac{1.0}{1.533} = 0.652$). Therefore, the minimum radius of the bend which will assure maximum light on the dial face (using thickness of 0.115"):



Inside Radius = 0.215 in. minimum
Outside Radius = 0.215 + 0.115 = 0.330 in. (minimum)

The molded dial face should also be given a 2°-3° taper for maximum face illumination. The final design will be as in Fig. 3.

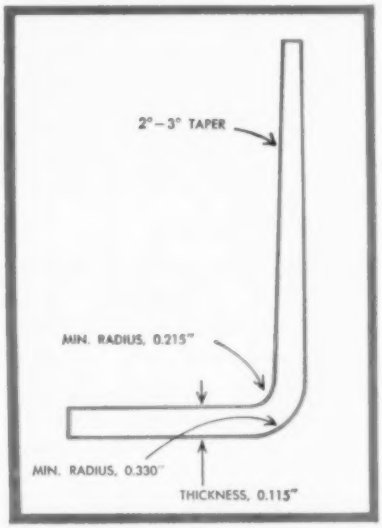


Fig. 3—Design solution.

Continuing studies by Dow Plastics Technical Service Engineers are providing valuable data, of the kind above, to assist designers and plastics engineers in all phases of plastics technology. For detailed information on these studies write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 1731DT3.

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Zerlon® • PVC Resins
Ethocel® • Pelaspan®
Tyril® • Saran

PLASTICIZERS FOR VINYLS THAT REALLY GO PLACES

In 1960, for the second successive year, vinyls shared the honor of being one of only two plastic materials to break the billion-pound-per-year mark.

In this growing market, RCI PLASTICIZERS and stabilizers continue to meet an ever-increasing number of vinyl industry requirements. The newly combined RCI and Deecy line includes many ready-made plasticizers as well as a number of customer-tailored ones – all developed to help you increase your products' market-ability.

ADIPATES, EPOXIES, AZELATES, MALEATES, SEBACATES, FUMARATES, PHTHALATES, RICINOLEATES and STABILIZERS are supplied by RCI. Choose for your requirements – high or low temperature flexibility, durability, light stability, low migration properties; or products sanctioned by the FDA for food packaging films.

RCI's service laboratories stand ready to help you solve specialized plasticizer problems and invite you to outline your specific needs. Write to Plasticizers, Reichhold Chemicals, Inc., RCI Building, White Plains, N.Y.

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Give the best possible control over Plastics molders and extruders.

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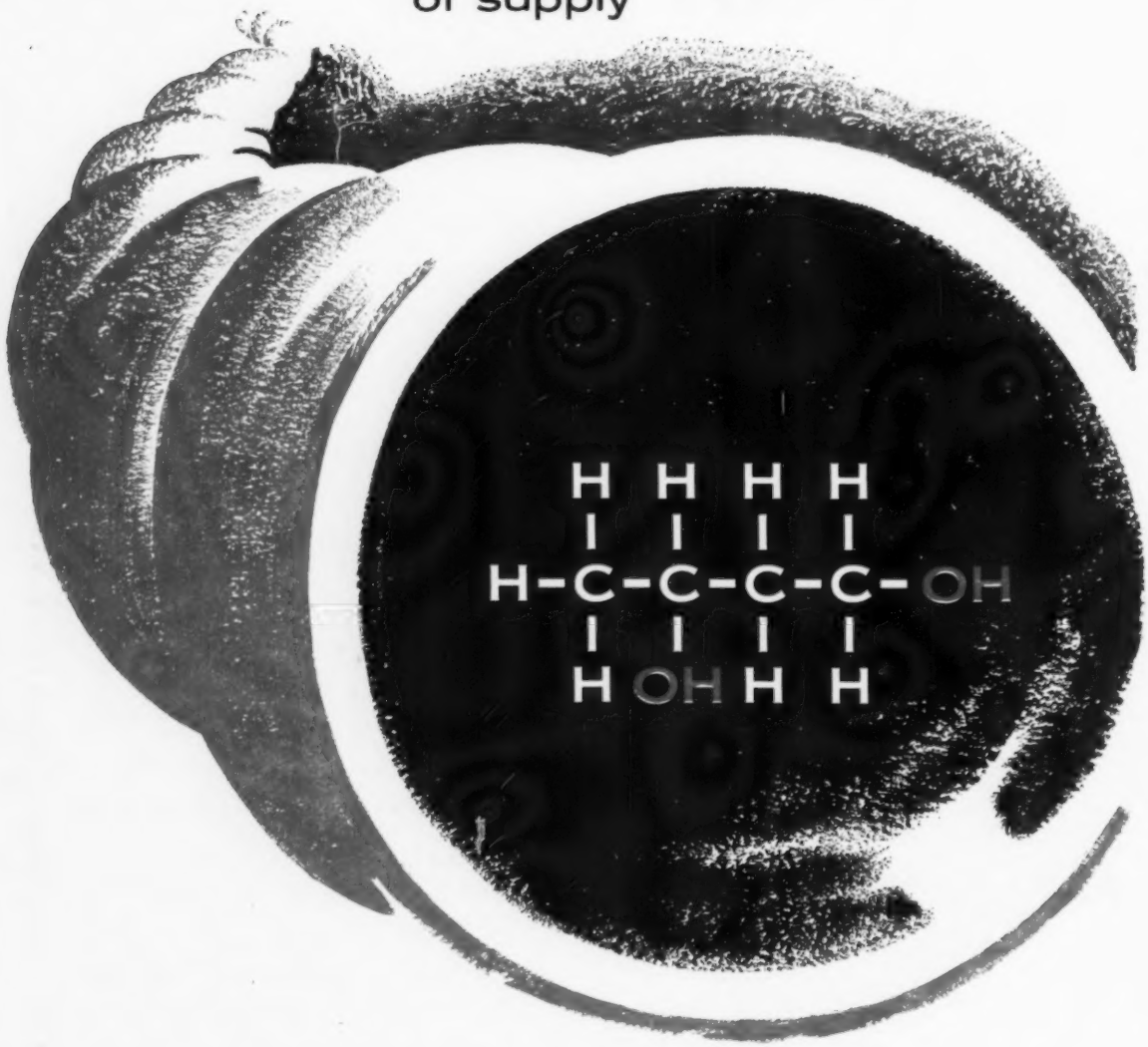
Celanese 25-million lb. production capacity for 1,3-BUTYLENE GLYCOL gives the plastics industry its first volume source of supply



Now there's enough of this versatile diol to meet your needs—*promptly* and *economically!* Celanese 1,3-Butylene Glycol has many advantages in the preparation of polyesters for coating materials, laminates, potting compounds, and plasticizers.

In polyester production, its relatively high boiling point permits the use of a higher reaction temperature. As a raw material for adipate and other plasticizers, it increases resistance to weather, water and oil. Used in polyesters for laminates and coatings, it increases flexibility and improves resistance to impact and outdoor exposure.

This glycol, like other Celanese glycols, is now available in tank cars, compartmented cars, and drums. Write for technical data, outlining your specific interest, to: Celanese Chemical Company, Dept.564-C,180 Madison Avenue, N.Y. 16.

Celanese®

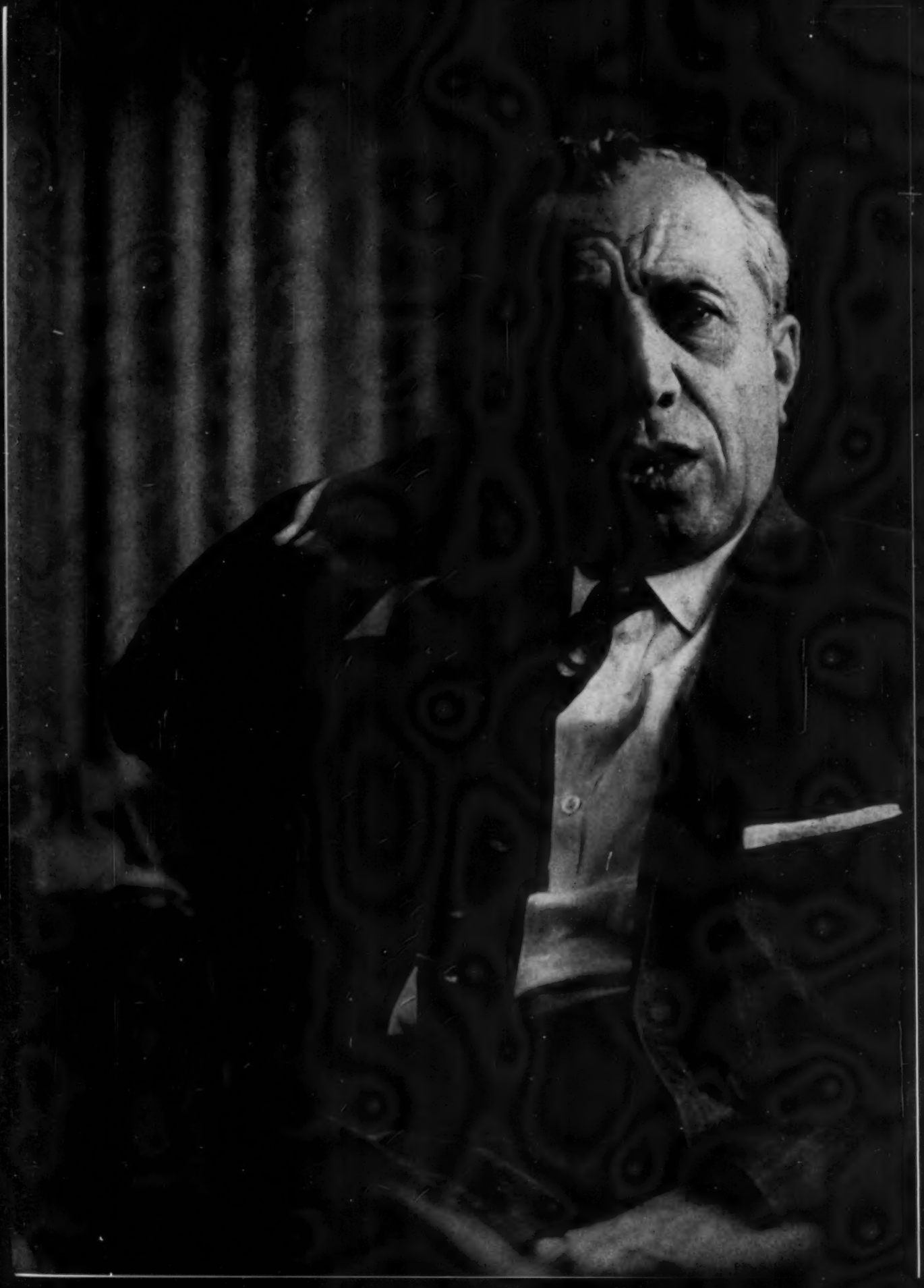
Celanese CHEMICALS

Celanese Chemical Company is a Division of Celanese Corporation of America.
Canadian Affiliate: Canadian Chemical Company Limited, Montreal, Toronto, Vancouver.
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16.

Editorial:

A man lived by the side of the road and sold hot dogs.
He was hard of hearing so he had no radio.
He had trouble with his eyes so he read no newspapers.
But he sold good hot dogs.
He put up a sign on the highway telling how good they were.
He stood by the side of the road and cried: "Buy a hot dog, Mister."
And people bought.
He increased his meat and roll orders.
He bought a bigger stove to take care of his trade.
He got his son home from college to help him.
But then something happened . . .
His son said, "Father, haven't you been listening to the radio?
If money stays 'tight,' we are bound to have bad business.
There may be a big depression coming on.
You had better prepare for poor trade."
Whereupon the father thought, "Well, my son has gone to college.
He reads the papers and he listens to the radio, and he ought to know."
So the father cut down on his meat and roll orders.
Took down his advertising signs.
And no longer bothered to stand on the highway to sell hot dogs.
And his hot dog sales fell almost overnight.
"You're right son," the father said to the boy.
"We are certainly headed for a depression."

** This page is appearing in March issues of these Bill Brothers Publications: Fast Food, Modern Floor Covering, Modern Tire Dealer, Plastics Technology, Rubber World, Sales Management and Sales Meetings. The source of the story is unknown to us and we will be grateful to anyone who can identify it.*



Joe Foster, President, indicates possible new applications for Nylon-6.

"Your competitors may be switching to Nylon-6 right now," says Joe Foster

Could be. It's worth thinking about.

For one thing's sure—Nylon-6 is one of the great molding resins, one that's bound to be popping up before long in exciting new applications. In portable electric mixers, maybe. Or transistor radios. Or electric shavers. Or even power tools.

But Nylon-6 should be part of your thinking for *several* reasons. Not just because of what your competition may or may not be planning, but because of what this remarkable fabricating material itself has to offer—a *unique combination* of advantages. Colorability. Non-flammability. Ease of molding and extrusion. Strength. Toughness. Abrasion-resistance. Impact-resistance. Flexibility. Heat stability. Self-lubrication. *And* the extra merchandisability of "Nylon" adds magic sales-power to all types of products.

As the world's largest manufacturer of sunglasses (with Nylon-6 frames) and a leading resin producer, we have great confidence in Nylon-6. That's why we recently acted to speed new applications, by reducing the price of Fosta® Nylon—our Nylon-6—to 98 cents a pound in quantity.

Like to find out more about Nylon-6? We'll be glad to send you current literature on Fosta Nylon. Just call us at KEystone 4-6511 or write Foster Grant Company, Inc., Leominster, Mass.

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Winter-summer flexibility and durability for vinyls

MONOPLEX® S-73, an epoxy-ester plasticizer for vinyls, provides a combination of flexibility at freezing temperatures and durability in summer sunlight. And even though MONOPLEX S-73 shows permanence properties superior to most other low-temperature plasticizers, its cost in the vinyl compound is usually lower.

The unusual permanence properties of MONOPLEX S-73 stem from: (1) its stabilizing effects against heat and ultraviolet light degradation, (2) low volatility, (3) good compatibility with PVC, even under rigorous exposure conditions, (4) better resistance to migration than normally shown by low-temperature plasticizers. Excellent color and clarity of MONOPLEX S-73 make it an ideal choice for transparent rainwear, rear windows for convertibles, and auto seatcovers. Its viscosity properties are excellent for plastisol uses. Economy comes from moderate price and low specific gravity. Write for two free booklets: *Performance Properties of* PARAPLEX® *and* MONOPLEX *Plasticizers*, and *Properties of Plastisols.*

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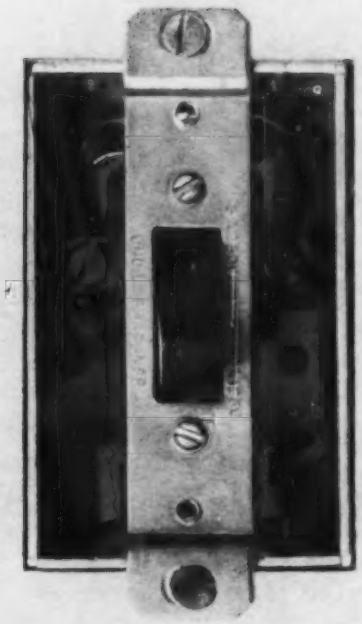
MONOPLEX S-73



The switch is to decorated Beetle® Urea Plastic. Now you can mold multi-colored decorations into switch plates, stove hardware, business machine keys, temperature indicator knobs, electrical appliance housings, and countless other products—and maintain production economy! By incorporating a patterned, resin-impregnated foil during the molding process, you avoid costly after-decoration. The pattern becomes part of the molded Beetle Urea plastic. It won't chip off, scratch off or wear off. And you still enjoy these proven Beetle plastic advantages: resistance to detergents, oils and grease; arc-resistance; track-resistance; good dielectric strength; surface hardness; stain resistance; wear-resistance; unlimited range of colors. Write for complete information or call your local Cyanamid representative.

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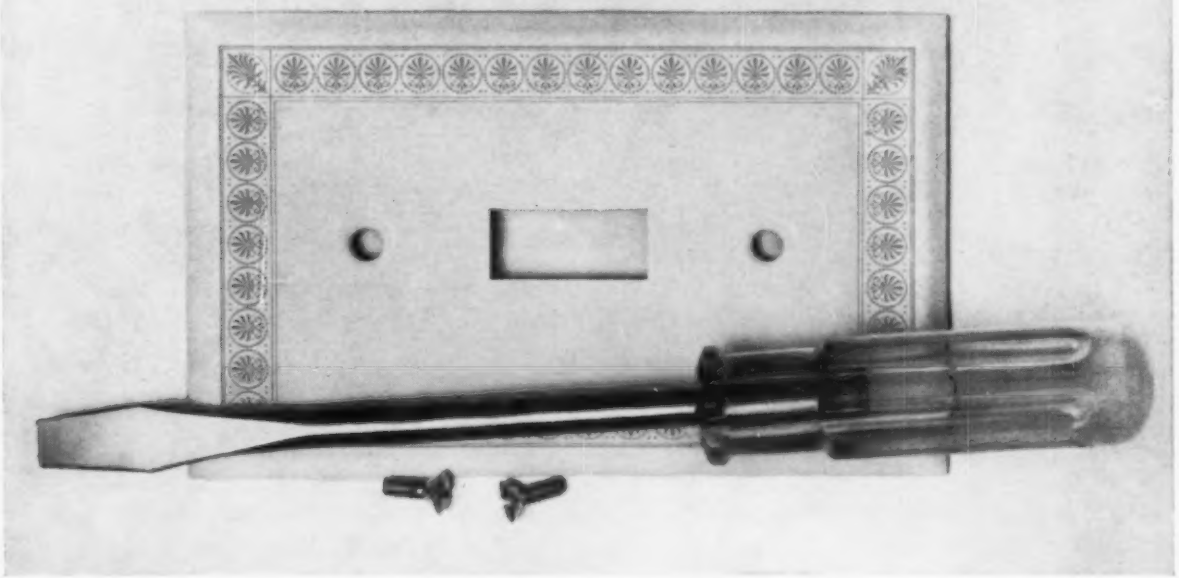
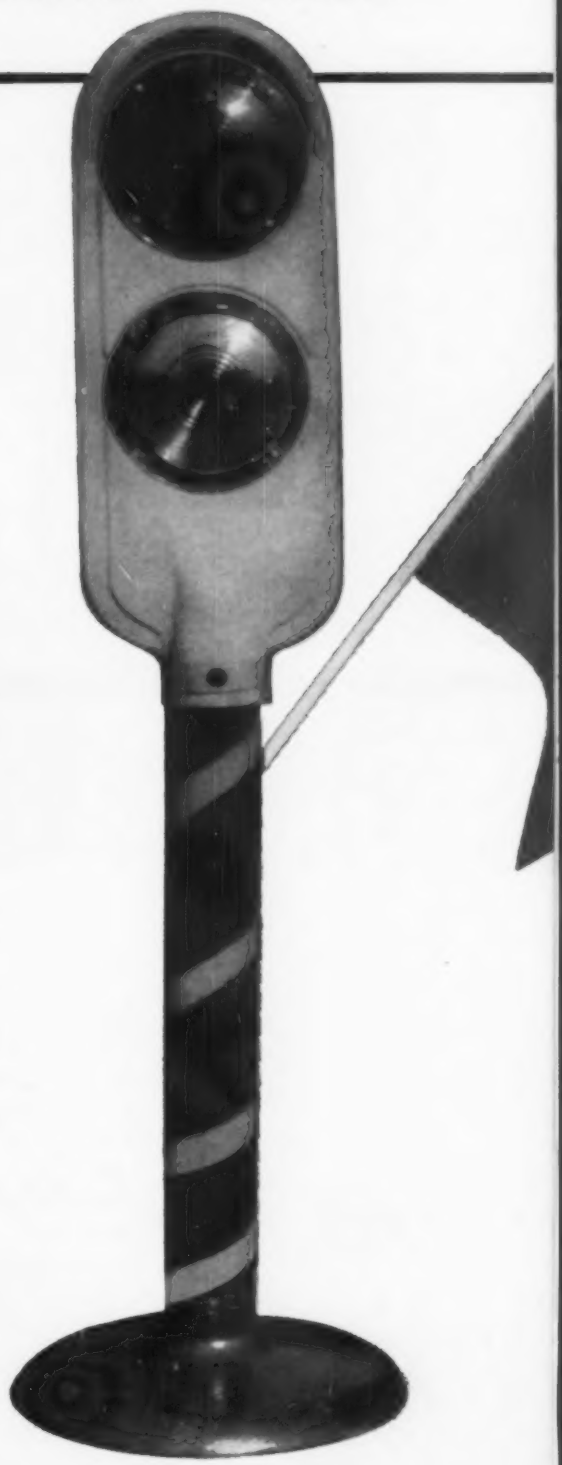


Formed entirely in one piece, this seamless plastic blinker housing measures 24" long, 8¾" wide, and 1½" deep at its narrowest part. It is molded by DeWitt Plastics, Auburn, N. Y. for Roberts Enterprises, Inc., Cazenovia, N. Y.

STOP...LOOK WHAT'S NEW

IN BLOW-MOLDED POLYETHYLENE!



This flashing road barricade is a beacon of safety for motorists. Its yellow plastic blinker housing shows something else, too. Good design. Selection of the *right* process, the *right* material. Only blow molding could make this part in one piece. And BAKELITE Brand high-density polyethylene provides the durability to stand long, tough outdoor use.

The background of UNION CARBIDE in blow molding dates from the earliest application of polyethylene to squeeze bottles. At our laboratories in Bound Brook, N. J., a battery of all major types of blow molding machines reproduces practically every set of production line conditions encountered in the process. As a result, BAKELITE Brand polyethylenes are engineered for performance in machine and product alike.

You can get every type of polyethylene for blow molding from Union Carbide Plastics Company. BAKELITE Brand polyethylenes range from low to high density materials, including .95 to .96 density types. Nowhere else in the industry is the list so complete. You get the benefits of one-source selection.

For information on how UNION CARBIDE materials and experience in blow molding can help you develop a successful product, write Dept. KZ-105C, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

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Whatever your plastic-reinforced product is, it will be better, stronger, more saleable when made from one of the family of Glidden GLIDPOL polyester resins . . . the resins that went UP the Colorado by jet!

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U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

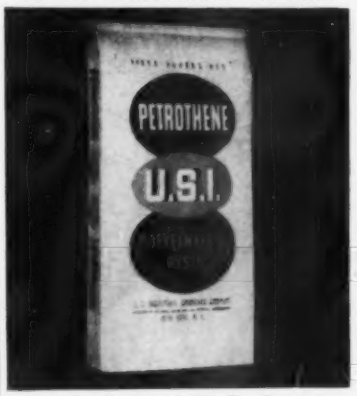
Packaging Notes

On-the-spot polyethylene skin packaging is revolutionizing the moving industry. With a new portable machine which can be rolled right into a home and run on any 110-120 volt circuit,

barrel packing can now be accomplished in 25% less time at a 33% savings in material costs. Device applies a tight, 6-mil polyethylene film cover over small or fragile articles, anchoring them firmly to a polyethylene-covered corrugated board. Full cycle is said to take less than 30 seconds. Standard moving barrels are used.

Because of its easy portability, this machine is also being utilized by manufacturers for in-plant packaging of electrical components, spare parts, etc.

New Bag For U.S.I. PETROTHENE® Resins



A newly-designed 50-lb. bag now packages U. S. I. premium PETROTHENE resins. It has an outer ply of semi-bleached Kraft, imprinted with a new 3-oval U.S.I. insignia. Look for this bright white, red and black bag, instead of the familiar red on brown one, next time you order.

Blow Molding Upturn Ushers In New Products

May Yet Rank With Injection Molding As Polyethylene Market

Blow molding, a 50-million-pound polyethylene market in 1960, is expected to show dynamic growth in 1961. Predicts Vincent D. McCarthy, Director of Plastic Sales for the U.S. Industrial Chemicals Co.: "This year blow molding will climb faster than ever . . . and may eventually compare with injection molding as a market for polyethylene." Injection molding now consumes 250 million pounds of conventional polyethylene yearly.

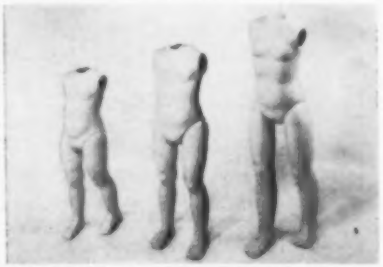
"The tremendous growth of blow molding high density polyethylene has also created a substantial demand for blow molding conventional polyethylene," he explains. "The use of conventional resins, either by themselves or in blends with high density resins, will continue to increase."

Technical advances are also contributing to blow molding's upward trend—spurring new products, creating new applications.

A Long Island, N. Y., plastics company, for example, is now making a walking doll 40 inches tall. New techniques, the recent acquisition of extremely large blow-molding equipment, and the consistent uniformity of the U.S.I. resin used are credited with making production possible.

And, from Europe comes report of the popularity of a polyethylene wine flask. Blow-molded in Portugal from a PETROTHENE resin, it's said to be ideal for short-time storage. A simple treatment overcomes any influence of polyethylene on flavor: Filling the container with pure water, leaving it for 24 hours, then emptying apparently does it.

In this country, news is being made by a 5-gallon *collapsible* jug—extrusion blow-molded from PETROTHENE by a Cleveland concern. This corrosion-resistant container can transport and store virtually any liquid, costs only about 90¢ with cardboard carton.



DOLL BODIES blow-molded of polyethylene to proportions of 2-, 3-, and 4-year olds. The biggest doll is 40 inches tall.

WINE FLASK and COLLAPSIBLE 5-GALLON JUG are typical of new products being blow-molded of U.S.I.'s PETROTHENE polyethylene resins.

Hot-Transfer Process to Decorate 300,000,000 Bottles

The tide of blow-molded bottles decorated by the relatively new hot-transfer method is rising steadily. According to the company developing the process, it will be applied to more than 300 million plastic bottles during 1961.

Success of the technique is attributed to both its efficiency, and the recent breakthrough of low-cost, semi-rigid polyethylene bottles.

Reportedly, equipment is now available for applying multicolor designs to bottles of any shape "at speeds up to 100 units a minute at a fraction of the cost by other methods."

Automatic machine applies wrap-around labels to cone-shaped bottles. Design is reverse-printed on heat-release coating. Post-heating ovens impart gloss to the transferred printing.

Pipe, Fittings of Polyethylene OK'd by New York City

For the first time, the N.Y.C. Board of Standards and Appeals has approved polyethylene pipe and fittings for acid and chemical waste systems. The approved drainlines, made by a Rochester, N. Y., company, are now also acceptable to Buffalo, Cincinnati, Detroit, Los Angeles, the State Plumbing Code of Michigan and the Plumbers' Examining Board of Richmond, Va.

U.S.I.

Series VI, No. 2

POLYETHYLENE PROCESSING TIPS

HOW TO PREVENT RESIN CONTAMINATION IN YOUR PLANT

Contamination in polyethylene resins can mean increased down-time and lower product quality. Both are costly results which can be prevented by a few simple precautions in handling and processing resin.

The producer, of course, has the responsibility to make sure that resin arrives at your plant in virtually contamination-free condition. U.S.I., for example, carries out strict quality control sampling of every PETROTHENE® polyethylene lot produced at its Tuscola, Ill., and Houston, Tex., plants. Engineers also maintain a constant check on production and handling facilities to detect possible sources of contamination before they can cause trouble.

Once the resin arrives at the customer's plant, it is his responsibility to prevent contamination during handling and processing steps. This is relatively simple if he follows the basic procedures outlined below.

Check the Container

There need be no question about the purity of PETROTHENE resin arriving at the processor's plant if the container is *sealed*. While all due care is taken in packaging and loading resins, some container breakage may occur.

Resin in containers arriving either broken or opened should not be used unless it is definitely established that no contamination has occurred. Instances of opened or broken containers should be reported immediately to the nearest U.S.I. sales office. This can help U.S.I. in determining where the breakage occurred and preventing its happening again.

In-Plant Conveying

Polyethylene resins are transported from their point of arrival in a processor's plant to the processing machine in a variety of ways. Which method is used depends on the type of container the resin is in and the size and type of processing operation involved.

In large operations, where Dry-Flo* carlots of resin are used, conveying systems are usually installed to move the resin either directly from the car to the processing machine, or from the car to storage silos, and eventually, to the processing machine. Where this is the case, the conveying system should be inspected regularly for loose fitting sections or other possible contamination entry points.

Hopper loaders of one type or another must be used with Sealdbin† shipments of polyethylene resin. These loaders should be designed to eliminate resin hang-up and checked regularly for possible points where contaminants can enter.

An important rule to remember is that any resin loading system should be closed. Resin containers or equipment hoppers which remain uncovered for long periods of time are a major cause of resin contamination.

*Registered trademark of General American Transportation Corporation.

†Registered trademark of United States Rubber Co.

Opening Bags

Most U.S.I. PETROTHENE polyethylene resin is shipped in 50-lb. multiwall paper bags. The inner ply has a coating of polyethylene to protect the resin from contamination by paper fibers, moisture and other foreign matter. Unfortunately, unless the bag is opened with care, bits of foreign matter may get mixed in with the resin.

First step before opening a bag is to brush the top section of the bag clean of any loose dirt and dust. Usually there is some, as this is unavoidable in shipping and storage.

Do not use a knife to open a bag. This will lead to contamination by paper fibers. The proper way is to open the bag by pulling apart the strings used to close its top after filling. The simple procedure for opening the bag is described in the data sheet, "How to Open a Polyethylene Resin Bag", which can be obtained from U.S.I. on request.

Opening Cardboard Containers

Cardboard containers of PETROTHENE resin are sealed with metal bands. In opening these containers, too, it is important to first wipe the top to remove dirt and dust which may have accumulated. As in the case with 50-lb. bags, cardboard boxes should never be opened with a knife. The proper method is to cut the metal bands and remove the container lid. The polyethylene liner found inside all U.S.I. cardboard containers should then be unfolded and placed over the top edge of the box before discharge of the resin. This liner helps further to protect the resin from contamination between charges to the processing machine hopper. The liner should be used to recover the unused resin before replacing the container lid.

Good Housekeeping

Even when all the above precautions are taken, some resin contamination may result from poor shop housekeeping. Processing areas should be kept clean so that dust and dirt, which can contaminate the resin during the brief intervals when it is uncovered, are kept to a minimum. A dirty processing area will always cause some degree of resin contamination, regardless of other steps taken to prevent it.

The last place where resin contamination can occur is in the processing machinery itself. Since this "Processing Tip" is primarily concerned with eliminating foreign material in the resin cubes and pellets, listing good processing practices in detail is beyond its scope. It is important to remember, however, that regular maintenance and cleaning of processing machinery not only will prevent resin contamination but also will insure optimum machinery and resin performance.

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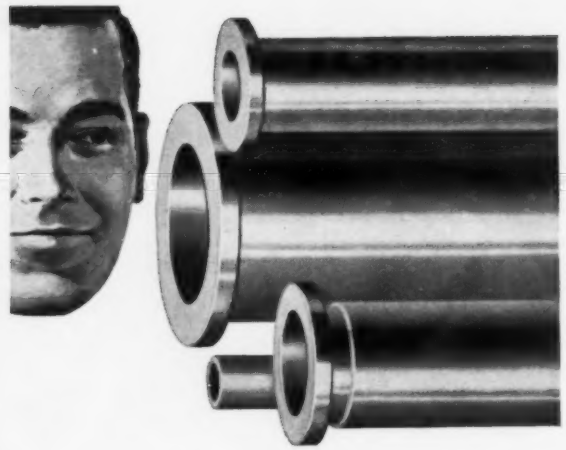

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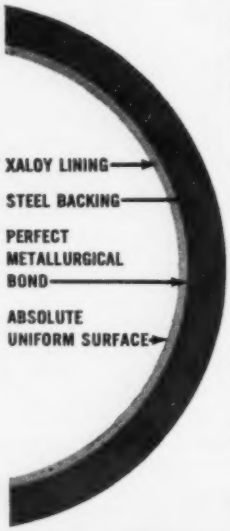

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$5 billion

That's the plastics market forecast for 1961. It's a lot of money and the people attending the Ninth National Plastics Exposition, June 5-9 at the New York City Coliseum will be responsible for spending most of it.

This is a big responsibility. We want to help our readers organize their time to get the most out of the exhibits. For this reason our engineering editor has collaborated with the editor of Sales Meetings (a sister publication) in preparing a unique article — "How to get the most out of the 9th National Plastics Exposition." This article will give tips and advise on planning their time in hunting for ideas for new applications, improved processing techniques, and better engineered products.

To get the attention you deserve at the industry's biggest show schedule *now* an ad in Plastics Technology's special May issue on the Exposition to focus attention on your own display.

Other special sections guarantee an unusual amount of readership both before, during and after the show. Among the planned editorial features:

- A carefully compiled list of exhibit features worth special attention.
- Classified list of materials and equipment.
- List of exhibitors.
- Floor plans of the exhibit areas.

Be sure you get the most out of it, too. Reserve space *now* in Plastics Technology's special Exposition issue.
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TECHNOLOGY
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PHILLIPS 66 MARLEX PLASTICS

BRIEFS

SALES SERVICE LABORATORY — REPORT 61-1

Our newsletter, introduced last year to a limited audience, is (we are pleased to announce) now being carried in most plastic trade magazines. Its purpose is to give us lab fellows a chance for a little broadcasting about our work . . . keeping MARLEX customers—and potential customers—up-to-date on new developments, our latest technical reports, and the like. From time to time we may do a little editorializing, too!*

High Density Ethylene Copolymers . . . After Two Busy Years!

Our ethylene-butene copolymers were first made commercially available in September, 1958. Since that time, these MARLEX 5000 resins have been a phenomenal success—especially for blow molding detergent bottles. They are also widely used for injection molding, fibre extrusion, wire and cable coating and non-container blow molding.

In physical appearance, temperature range (−180°F to 250°F), light stability, freedom from color and odor . . . the various melt index types of these new copolymer resins are similar to our original high density polyethylene (MARLEX 6000 resins). The main difference is in density (0.950 for the copolymers and 0.960 for the polyethylenes) and in the superior stress cracking resistance of the copolymers. They gain this desirable attribute at the expense of a nominal loss in tensile strength, rigidity, and resistance to permeation.

Stress cracking is a phenomenon not fully understood . . . although molecular weight, density, and molecular weight distribution are acknowledged as contributing factors. In all probability, the marked increase in both thermal and environmental stress cracking resistance exhibited by these new ethylene copolymers results from an optimum balance between density and molecular weight.

What all this boils down to is a wider choice of high density MARLEX resins. In applications requiring maximum rigidity and resistance to permeation, our 6000 resins are still unbeatable. Where these requirements are not uppermost, the new 5000 resins offer distinct advantages.

We have just published a new booklet on MARLEX High Density Ethylene Copolymers. It gives the complete story—charts, test data, physical characteristics, etc. If you haven't received a copy, let us know. Ask for Technical Information Bulletin #26.

Pipe and Conduit . . . Comments and New Data

Last year we talked of the potential demand for MARLEX pipe and conduit by utilities, municipalities, and industry (power, telephone, gas, water, and sewage). We have been developing this market for our TR-213 (a high density polyethylene tailored resin) and TR-212 (an ethylene copolymer tailored resin). Millions of pounds of MARLEX have gone into pipe and conduit in the last year—a very encouraging start.

Utilities and municipalities are tough customers . . . and very conscious of cost and overall performance. So far, we're proud to say MARLEX pipe and conduit resins have been enthusiastically received. Word gets around . . . and the lid is off.

How big is the potential market? It's almost hard to imagine. For those who like statistics, we offer some from the American Gas Association covering just a small part of the total market. The A.G.A. sees another 10 million gas customers in the next 10 years, each a user of 2" or smaller secondary distribution pipe. (Let's see, if each customer requires 150 feet of—ah . . . hum!) In addition, A.G.A. calculations of larger diameter primary distribution and gathering lines project some 520 miles per year for the next 10 years.

Rigid 5" MARLEX pipe and conduit like this is now being used for low-pressure gas, oil and water lines, power and telephone conduits, and sewer mains.

Our production department is geared to supply ever-increasing quantities of MARLEX pipe and conduit resin. In addition, we have just published some up-to-date information on pipe and conduit extrusion. This revised Technical Information Bulletin #15 is concerned with the external sizing technique of extruding high density MARLEX pipe. Let us know if you are interested.

New Resin for Coilable Pipe

Another important pipe item! We've just introduced a new high density pipe resin tailored for the coilable merchant pipe market. Pipe extruded from this new resin, called MARLEX TR-414, meets all requirements of Department of Commerce Standard, CS 197-60, for ASTM type III polyethylene, which uses a design hoop stress of 600 psi. It is approved by the National Sanitation Foundation, of course. Incidentally, TR-414 produces the most flexible ASTM type III pipe on the market. As a result, this pipe is ideal for sprinkler systems, potable water systems, farm water lines, and jet wells.

Breakthrough in The Auto Industry

Most manufacturers and material producers who make good in the auto industry manage to boast about it. We're no exception. In the 1961 models we have "scored big". By recent count our MARLEX resins are being used in about ten basic applications—such as seat side shields, side cowl panels, heater and defroster ducts, windshield washer bottles, glove boxes, and spring interleaf silencers. The total estimate for all high density polyethylene in 1961 cars and trucks is figured at close to six million pounds.

"Improved performance at equal or less cost" is almost an auto industry maxim for selecting something new. We feel their increasing use of MARLEX resins is a good testimonial.

*MARLEX is a trademark for Phillips family of olefin polymers.

PHILLIPS CHEMICAL COMPANY, *Bartlesville, Oklahoma*
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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

Low/No pressure fabrication of silicone laminates

D. T. RETFORD*, M. E. NELSON* & K. R. HOFFMAN*

The dynamic electrical and electronics industries are always searching for means to improve the performance and reliability of electrical devices. Silicone dielectrics have aided in this search because of their superior thermal stability, dielectric properties, and moisture resistance (1,2).** Reinforced silicone laminates have played and continue to play an important role in this program.

Flat-sheet silicone laminates are used to make slot wedges, spacers, mounting boards, insulation washers, coil forms, and related parts. Molded, reinforced-silicone laminates are used for transformer barrier tubes, coil forms, and radomes.

In the past, it had been necessary for fabricators to obtain silicone-preimpregnated, B-stage reinforcement to produce silicone laminates. Curing was normally done in a hot press. These requirements limited the number of silicone laminate fabricators to those with curing presses and facilities for impregnating and/or storing silicone-impregnated glass cloth.

To overcome these limitations, a silicone resin system was developed. These resins, designated Dow Corning R-7145 and R-7146, are low-viscosity, solvent-free liquids. Chemically, they are vinyl-containing, linear polysiloxanes which cure through an addition reaction.

It is the cure mechanism that makes these silicones different. All earlier silicone laminating resins cured through a condensation reaction which formed water vapor. This vapor caused excessive void spaces in the finished laminate if external pressure was not applied during cure. However, no volatile gases are produced when an addition reaction takes place and external pressure is not necessary to prevent void formation during cure of a solventless silicone laminate.

From the practical point of view, the new silicone resins have the necessary properties and cure characteristics that allow a fabricator to use wet layup techniques and oven cures to obtain thick, void-free laminates. This means that any fabricator can take dry reinforcement "off the shelf," wet it with a solventless silicone resin—also "off the shelf"—and make a reinforced silicone laminate. This laminate will have the excellent electrical properties and thermal stability typical of silicone laminates.

Layup procedure

Handling procedures for making a reinforced, solventless silicone laminate are similar to those used mith polyesters. However, there are certain differences which require detailed discussion. The resins are low-viscosity, solven-free liquids as shown in Table 1.

Table 1. Typical Resin Properties

Property	R-7145	R-7146
Color	Light Straw	Light Straw
Silicone Resin Content, Percent	100	100
Specific Gravity at 25C (77F)	1.13	1.11
Viscosity, centistokes		
at 25C (77F)	2200	130
at 100C (212F)	100	18
Pot Life at Room Temperature, catalyzed	>6 months	>6 months
Shelf Life at Room Temperature, uncatalyzed	>12 months	>12 months

They must be catalyzed with a suitable peroxide catalyst to initiate cure; in this case, dicumyl peroxide, a solid at room temperature.

About 2% Dicup-R† was first dispersed in resin, and the mix heated to 150° F. to melt and dissolve the peroxide. There was no danger of premature gelation, since pot life of the catalyzed resin is in excess of one month at that temperature. The catalyzed resin was cooled to room temperature and stored for periods in excess of six months without either catalyst separation or resin gelation.

Layups were made by alternating layers of glass cloth and catalyzed resin. To aid in handling, the layups were made on heat resistant cellophane (DuPont PC 600). A small puddle of resin was poured on the

* Product Engineering Labs., Dow Corning Corp., Midland, Mich.
** Numbers in parentheses refer to bibliography at end of article.

† Tradename for dicumyl peroxide, Hercules Powder Co.

D. T. Retford

M. E. Nelson

K. R. Hoffman

cellophane sheet and the first ply positioned. More resin was poured on the center of each successive ply until the desired number was reached. Resin was not spread until another sheet of heat resistant cellophane was placed on top of the layup.

At this point, resins were spread by applying slight hand pressure on the center of the layup, thus reducing the amount of entrapped air. Any entrapped air bubbles were worked out to the edge by applying hand pressure through the slip sheet.

Table 4 shows the effect of various glass cloth finishes on the physical strength of laminates made by wet layup. These data were tabulated to indicate the results which a fabricator could expect when he made a reinforced, solventless silicone laminate from the particular type of finished glass cloth he had on hand. Heat-cleaned glass fabric provided the best finish.

Manufacturing techniques

Many applications for reinforced silicone plastics require a complex (not flat) shape. Although the general procedures for fabricating such a part are the same as those used with polyester resins, some special techniques are required to ensure good laminates.

First, the form on which the layup is to be made must be cleaned and coated with a silicone release agent. A dry layup is positioned on the form and then saturated with the resin, either by brushing or by some other suitable method which avoids entrapping air bubbles.

The surface of the wet layup must be covered with PVA film or heat resistant cellophane to prevent inhibition of cure at the surface. This could occur because the peroxide reacts more readily with the oxygen in the air than with the vinyl groups in the resin. Such an interaction of the peroxide and air causes these surface vinyl groups to remain unreacted and a tacky finish results.

Resin movement within the laminate must be controlled during cure. There is a rapid decrease in viscosity of the resin as it is heated in the curing oven (See Table 1). When cure temperature is reached, gelation commences and the apparent viscosity of the resin rises rapidly. However, the initial viscosity decrease requires that special techniques be used in fabricating a part containing vertical sections. If precautions are not taken, the resin will run out leaving dry spots in the finished laminate.

Table 2. Physical Properties

Property	R-7145		R-7146	
	As Cured	Heat Aged*	As Cured	Heat Aged*
Tested at 77° F				
Resin Content, Percent	38-43	—	38-43	—
Barcol Hardness	50	55	49	54
Water Absorption, 24 hr, %	0.14	0.25	0.04	0.23
Flexural Strength, psi	32,700	29,950	39,870	31,400
Compressive Strength, psi	18,400	20,300	23,165	20,400
Tensile Strength, psi	23,200	23,220	27,200	23,300
Flexural Modulus, psi x 10^6	0.917	0.915	1.088	1.068
Compressive Modulus, psi x 10^6	1.840	1.950	2.130	2.210
Tested at 500° F				
Flexural Strength, psi	5,570	6,760	3,850	4,580
Compressive Strength, psi	2,745	2,735	1,345	1,880
Tensile Strength, psi	11,500	12,000	10,000	10,150
Flexural Modulus, psi x 10^6	0.149	0.776	0.331	0.563
Compressive Modulus, psi x 10^6	0.534	0.554	0.350	0.478

Measured on ⅛ inch thick laminates using 181-112 glass cloth cured at contact pressure for 3 hours—300°F, 3 hours—400°F and 3 hours at 482°F.
* Heat aged 200 hours at 482°F (250°C)

Table 3. Electrical Properties[1]

Property	R-7145		R-7146	
	As Cured	Heat Aged[2]	As Cured	Heat Aged[2]
Dissipation Factor, 1 mc.				
Condition A[3]	0.002	0.002	0.002	0.001
Condition D 24/23[4]	0.008	0.030	0.014	0.028
Dielectric Constant, 1 mc.				
Condition A	3.60	3.88	3.63	3.80
Condition D 24/23	3.67	4.19	3.70	4.02
Surface Resistivity, ohm				
Condition A	5.3×10^{14}	1.4×10^{16}	8.1×10^{14}	8.5×10^{14}
Condition C 96/23/96[5]	5.9×10^{10}	1.8×10^{10}	2.2×10^{12}	3.7×10^{9}
Volume Resistivity, ohm/cm				
Condition A	2.6×10^{15}	3.2×10^{16}	5.1×10^{15}	1.7×10^{15}
Condition C 96/23/96	3.9×10^{11}	3.0×10^{12}	5.5×10^{12}	3.0×10^{10}
Arc Resistance, sec.	39	51	10	116
Electric Strength, volts/mil	275	280	334	250
Electric Strength Retention at 482° F, Hours[6]	360-384	—	360-384	—

1. On 1/8 in., 181-112 glass cloth laminates cured 3 hours—300°F., 3 hours—400°F., and 3 hours—482°F.
2. Heat aged 200 hours at 482°F (250°C)
3. Condition A—As received
4. Condition D—After 24 hours immersion in water at 23°C
5. Condition C—After 96 hours at 96% Relative Humidity at 23°C
6. Hours of aging at 482°F at which electric strength (in air) of a 1/8 inch thick laminate falls below 20 KV. (160 volts/mil)

To restrict resin movement in a laminate of uniform cross section, (such as a tube), the laminate may be wrapped tightly with the surface covering material. Resin flow in complex shapes of uneven cross sections can be controlled by curing in a vacuum bag or by the addition of a thixotropic filler to the resin before layup. Extreme situation may require some combination of these methods.

Vacuum bag laminating is readily adaptable to use with solventless silicone resins. It not only ensures good compaction on curves and angles, but restricts resin flow during cure. The procedure is quite similar to the method used in contact pressure laminating. The layup is made dry and positioned on the form, using glass-backed, silicone adhesive tape if necessary to hold the reinforcement in place.

The dry form is then placed in a PVA film vacuum bag on top of a puddle of catalyzed resin. The dry layup is preferred, since it is easier to handle and entraps less air than a wet layup. A bleeder mat, such as a glass-wool blanket, is placed on an uncovered portion of the form and the vacuum lead positioned over the center of the bleeder mat (See Fig. 1). The vacuum bag is sealed and a vacuum of not more than 20 inches of Hg. drawn. If higher vacuums are used, an excessive amount of resin will be squeezed out. After drawing vacuum, the resin will spread normally throughout the reinforcement, although some manipulation of the PVA film may be necessary to wet all portions of the layup. The layup is cured in the usual manner, maintaining the vacuum during the initial cure.

Special cure techniques may be required when the layup is bulky or made on a heat sensitive form. These conditions usually prevent oven curing of the laid-up form, and hardening is effected with infrared lamps. Lamp heating must be uniform and not too intense. After the resin hardens, the layup is removed from the form and given the normal oven cure, starting at 300° F., to develop maximum properties.

Other techniques commonly used in wet layup fabrication have been used successfully with these resins. Tubes have been made by wrapping dry asbestos paper or glass mat on a mandrel and vacuum impregnating with resin. These tubes have shown potential as transformer barrier tubes (3). One such tube was heat aged 1,000 hours at 575° F. without losing its physical strength and still possessing electric strength in excess of 160 volts per mil. Other tubes were prepared

Fig. 1. Vacuum bag laminating with solventless silicone resin.

Table 4. Comparison of Effect of Cloth Finish on Physical Properties

Cloth Finish	Laminate Color	Flexural Strength in psi tested at 77° F	Flexural Strength in psi tested at 500° F	Compressive Strength in psi tested at 77° F	Compressive Strength in psi tested at 500° F
Heat Cleaned	Translucent White	34,400	4,310	20,100	2,200
Volan A	Light Green	31,900	4,400	18,800	2,040
Y-1100	White	30,700	4,030	17,300	2,250
Garan	Light Brown	28,200	4,290	19,000	2,300
Starch	Light Yellow	24,200	4,000	13,900	1,900

Dow Corning R-7145 Resin on 181 Glass Cloth. Laminates Vacuum Bag molded at 20 inches HG and cured 3 hours—300°F, 3 hours—400°F and 3 hours—482°F.

by passing continuous roving through a dip tank containing resin and then winding on a mandrel. Molding with matched metal dies using glass roving and filled resin has also been successful.

Commercial applications

Although the description of manufacturing techniques has been detailed, it can be seen that the use of these resins in any particular application is not complicated. The solventless silicone resins are not designed to replace, but rather supplement conventional silicone laminating resins in areas where advantage can be taken of their unique properties. These include special processing techniques, and/or where short run or prototype fabrication is required.

A West Coast electronics firm uses these resins to produce high quality airborne transformers. The transformer windings are wound around a glass tape-reinforced silicone tube. The manufacturer describes the production of these tubes (4): "The tubes must be fabricated readily in hundreds of different dimensions, shapes and sizes with uniform characteristics. Construction must lend itself to extreme flexibility for short runs with minimum set up time and simple tooling. Many thousand high quality transformers have proved the reliability of R-7145 as a bonding agent for the fiber—glass tape on the start tubes. These units are processed on a production basis by production personnel".

Other firms are using these two resins with the same equipment they normally use to make polyester reinforced plastics. This enables them to offer high temperature, reinforced-silicone parts without the expense of purchasing special equipment.

Summary

Solventless silicone resins are unique. They have low viscosity in a solvent free state which permits easy handling and application. They cure by an addition reaction which prevents void formation during laminate cure. These characteristics permit them to be used in already familiar wet layup techniques.

They are not designed to replace conventional silicone laminating resins. Rather, their use will grow in situation which can utilize their particular properties and versatility of application. These areas include prototypes, short runs, and with existing polyester resin processing equipment. Laminates have good strength, excellent electrical properties, and are thermally stable.

Here are two, solventless silicone laminating resins which cure by an addition reaction. Since they do not give off water vapor, they require little or no pressure for cure. Any fabricator can use them, since they do not require extensive storage facilities nor expensive curing presses. This is especially advantageous for short runs and prototype fabrication.—Editor.

—THE END

"Markets for Flexible Foams" by P. B. Nortman

So many of you have written in for copies of this article that we decided to reprint it as a booklet. For those who may have missed it, the article surveyed markets for polyurethane, vinyl, and latex foams by fields—auto, furniture, etc. Special emphasis is placed on the urethanes.

50¢ per copy

PLASTICS TECHNOLOGY

630 Third Ave.

New York 17, N. Y.

Abrasion and wear resistance of reinforced polyester surfaces

This paper reports exhaustive testing by all known methods, employing all known variables. It also points out the fact that added test methods are needed before test results can be correlated to actual service life. Interesting to note, the Videne surface overlay stood up very well under abrasion. This same material is now being used by U. S. Plywood to protect the surface of its new Permagard. A thermoplastic polyester, Videne can be laminated directly to the wood surface.—Editor.

C. B. SIAS*

Plastic laminates have largely taken over the kitchen table, bar and counter top applications in the last 20 years. Wherever hard usage is encountered, the laminated tops can be counted on to do an excellent job in furnishing colorful, easily cleaned, scratch and wear resistant surfaces. Melamine surface laminates, produced under high pressures, have proven outstanding in abrasion and wear resistance characteristics.

Polyester laminates, prepared under low or no pressure conditions, will also give good service where a relatively heavy layer of resin is included on the surface. Heavy resin surfaces are somewhat of a problem in matched-metal molding operations, particularly without the use of veil mats or papers. Materials, methods, or techniques for obtaining more abrasion-resistant surfaces are of considerable interest for anyone molding furniture, fixtures, bathtubs, panels or similar products.

Our problem was to produce the best possible school desk top using a polyester molding process. The Taber abrasion resistance of laminates and moldings had been determined earlier for many resin and molding combinations. A study of the abrasion data in the PPG Laboratories and in the Reinforced Plastics Industry as a whole, indicates a need for additional data, and probably additional testing procedures, to determine the effects of material and process changes on abrasion and wear resistance.

A review of the literature for the past 20 years shows that, as in impact testing, there are more test methods than absolute results. Grinding wheels, fresh sandpaper surfaces, shoe soles and tooth brushes with sand, wind blown or falling particles, rain drops, and even washing machines have been used to obtain a reproducible wear or abrasion factor. The Taber and NEMA abrasion tests gave comparative results, but their exact meaning in terms of the life expectancy of a school desk top had not been determined.

Burnhardt** presented an intriguing approach to the problem of abrasion and wear resistance in a discussion of penetration and scratch propagation loads, scratch velocity, influence of coefficient of friction, etc. The two types of scratches: the scratch which merely deflects or distorts the plastic surface, and the scratch that actually causes material tearing or separation. Depending on the load applied, one could determine the possible life of products which will be subjected—not to a rotating wheel or a sandpaper surface; but to sand in the pants, a doodling pencil, or a sliding metal lunch box.

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** ASTM Bulletin No. 157 p. 49-53 (March 1959).

We felt it desirable to include in this evaluation program a test that would show the comparative "threshold" or minimum loads required to cause resin flow, or deflection and actual tearing, or resin separation. The Taber Instrument Company supplies a diamond point scratch tool which gave satisfactory threshold load values. These threshold loads, along with Taber and NEMA abrasion and the Taber scratch tests (widths of scratch versus load applied) were used to evaluate the numerous castings and laminates prepared for this study.

Test variables

Perhaps the easiest part of a study of this kind was the preparation of a list of variables; and the hardest, choosing the variables actually included in the program. We selected the following: resin types, raw materials, composition changes, processing conditions, and panel construction.

RESIN TYPES. Although polyester resins are the most widely used bonding materials for reinforced plastics, surface coatings of acrylic, epoxy, and urethane resins all have active or potential uses. These three types of coatings were deemed worthy of inclusion in the study and were applied to reinforced molded panels according to the best available techniques and approved practices. CR-39 (allyl diglycol carbonate), one of the most abrasion resistant plastic products, was also included as a standard or reference material.

RAW MATERIALS. One of the newer and interesting raw materials with an outstanding potential in polyester resins is isophthalic acid, and no study would be complete without its inclusion. Variations in monomer type and content will also influence properties of the molded panel surfaces, and two difunctional allyl monomers were used in place of styrene.

COMPOSITION CHANGES. The degree of the polyester's unsaturation has a direct bearing on many properties of the finished product. Past experience shows no positive direct variation of abrasion resistance with reactivity, although it would be expected that somewhat more abrasion-resistant surfaces should be obtained with the higher reactivity products. A hard surface is not necessarily the most abrasion resistant one. Look at such tough, flexiblized products as vinyl resins, which are used in flooring and other high wear applications. The possibility of obtaining material improvement in abrasion and wear resistance by the use of a flexiblized resin could not be overlooked or omitted.

The inclusion of fillers or other additives in the resin should affect the surface and wear properties. Fillers could spread the load of the deflecting point to reduce displacement and materially improve the overall resistance to resin separation which, after all, is necessary before wear is evidenced. Actual resin separation does not occur until the surface is penetrated by a foreign body, and a slippery or wax-like surface is usually more difficult to penetrate—particularly by a sliding or fast moving foreign body.

PROCESSING CONDITIONS. The wet-out time allowed for impregnation of the reinforcing material, the binder content on the reinforcement, and the type and degree of cure are all variables in the fabrication of reinforced plastic parts. The cure is considered to be the most important of these items, although wet-out should definitely not be overlooked. Variations in the curing conditions would include pressure, temperature, time, accelerator, catalyst, etc. The effects of these several variables were of definite interest, and they were included in the molding phase of the work.

PANEL CONSTRUCTION. Panel construction includes the base material, surface reinforcement, resin, and the method of applying the surface to the panel. Overlays, both reinforced and non-reinforced, mean heavy resin layers which should give optimum wearing characteristics. The use of veil mats or papers eliminates the problem of applying relatively thick, non-reinforced layers of resin to either the mold or the panel.

Overlays can be applied in several ways, and surface properties will vary considerably according to the procedure used. An overlay applied by spraying could have a considerably different styrene content from one applied by painting or pouring techniques because of monomer vaporization. Similarly, a resin surface cured rapidly in contact with a hot mold may be quite different from a cold-cured resin surface.

The reinforcing material in overlays can have considerable influence on abrasion and wear characteristics, and past experience has shown that inorganic reinforcing fibers frequently give less abrasion resistant surfaces than do organic or resilient fibers. Conditioning or "polishing" of a surface by dissolving the organic reinforcing fibers with a solvent dip was suggested as another method of varying surface abrasion and wear characteristics.

Surface coatings applied to a molding usually do not offer as much abrasion resistance as do molded surfaces. However, it was felt that available abrasion-resistant finishes should be examined for possible outstanding wear characteristics. Goodyear's polyester film (Videne) has been reported to give outstanding wear resistant characteristics when applied to the panel surface during molding, and was therefore included in this study.

Experimental procedure

Many variables can be studied in castings of the unreinforced resin: the isophthalic verus phthalic variations, the reactivity, the monomer content and type, and resin-flexiblization. Studies of accelerated surfaces, ultraviolet curing, varying catalyst concentration, and extended cure times were also conducted on the cast resin. A relatively thick casting cannot be cured at the same rate as a thinner molded product of lower resin content. Studies, therefore, were also run on the molded panels.

Wax and slip agents were added in both molded and cast panels to check their effects. Overlays were applied to reinforced panels, and both the reinforced and unreinforced overlay surfaces were prepared using hot and cold curing conditions. The reinforced overlays included Fiberglas (Owens-Corning) and Modiglass

(Modigliani) glass mats, cellulose, rayon, Dacron, and other synthetic fibers. The rayon-reinforced surfaces were dipped in acetone for one minute in an attempt to obtain a solvent polished surface.

Fillers were evaluated with molded panels because their settling rate make it difficult to obtain homogeneous castings. Molding rates are generally too fast for settling to occur; therefore, more uniform filler distribution is possible. It was suggested that orienting the fibers perpendicular to the surface would give improved abrasion resistance, but this was extremely difficult to do and no suitable panels were prepared in this fashion.

Evaluation tests

Castings were tested for penetration hardness using the Barcol Impressor, and for identation recovery using Rockwell M. The coefficient of friction was determined on an incline plane, measuring the resin surface against a cellophane covered wooden block. Earlier experiments showed this to give reproducible results.

Both the CS-10 and the CS-17 wheels were used in the Taber abrasion evaluation, since marked differences are often found between the results of the finer and coarser abrasive wheels. Losses were determind at 100, 500, and 1,000 revolutions. Values were calculated on the basis of mgs. lost per thousand turns, and are reported throughout the paper on this basis.

Greater uniformity was obtained at 1,000 turns than at 100 or 500 turns. The extreme variations encountered at 100 turns indicate that these values are not sufficiently accurate to give significant results. This is unfortunate, because it is the initial resistance to abrasion and wear that is highly significant in furniture and similar applications. The 500 and 1,000 turn values are reported for all cast and molded specimens, even though these values are somewhat less desirable than the 100 turn values.

Taber "Scratch Hardness" is determined by the use of a rounded cutting blade which will give a varying width scratch depending on the load and the resistance of the surface to penetration. The scratch factor is calculated by dividing the load in grams by the width of the resultant scratch and multiplying by 100.

The diamond scratch test was run in two phases; a width of scratch under varying load, and a "threshold" load test. The diamond tool indenter supplied by Taber was used at loadings of 125, 200, 350, and 500 grams. The width of scratch was measured and found to range from 1-3 millimeters as determined by microscopic procedures. The differences in scratch width were minor throughout the tests, therefore, of little or no significance.

The "threshold" load required to give surface deformation or flow with the diamond indenter was determined by increasing the load on the diamond point by 10-gram increments until a deformation could be observed. This deformation is merely a slight displacement or flow of the surface resin, and no actual loss of resin is encountered in determining the threshold flow value. As the load is increased, deformation becomes more pronounced until a point is reached at which resin particles are actually torn from the surface. This leaves white, multifacet particles characteristic of a scratched polyester surface, and represents the threshold tear value.

The threshold flow value is considered important, because it is the first point of resin surface failure. A light resin displacement can "self-heal" and may not be a permanent defect. On the other hand, the load at which resin tearing actually occurs is significant, since it indicates the load required to deface the surface permanently and give it an unhealing, permanent blemish.

NEMA specifies an abrasion test for decorative laminates using standard sandpaper strips as the abrading surfaces. The regular procedure requires that the test be continued until failure of the laminate pattern is observed. Since no pattern was included in the moldings tested, weight loss was used as the evaluating factor with the NEMA wheels. A 500-gram load, checked at 100 and 500 turns, was used to determine the NEMA wear resistance data.

Preparation of test specimen

Cast speciments were prepared by catalyzing the required resin and pouring it between glass plates, separated by a flexible gasket. These were placed in a circulating air oven at 140° F. until the resin gelled, and then given the required additional cure. Standard 4- by 4-inch Taber test specimens were prepared and all tests were run on these specimens, since the Taber scratch and diamond threshold tests may be run on specimens previously used for one of the other abrasion tests.

Moldings were prepared using 2 and 3 plies of 2-ounce, #219 fiber glass mat; 2-ply with overlay, 3-ply alone. A 12- by 12- by ⅛-inch, chrome-plated, matched metal mold was used for the actual molding operation. The resin was spread evenly between plies before the layups were placed in the mold. No resin was applied on the top surface of the veil, except in the case of the rayon cloth which did not wet out satisfactorily. Mold times and temperatures were set, and Mitchell-Rand 1894 mold release was used sparingly. The overlays were applied directly to the mold surface according to specified conditions.

The coated panels were standard polyester moldings, and coating materials were sprayed or spread upon the surface and cured according to specified procedures. The Videne-covered laminate was prepared using four plies of preimpregnated 181-136 fiber glass cloth. Videne was laminated directly to the cloth between cellophane slip sheets at a pressure of 400 psi., and a temperature of 230° F., for 3 minutes.

Experimental results

To establish inherent error and obtain a suitable basis for evaluating data, five specimens from a control casting or a control molding were run for each test procedure. These data are included in Table 1, and show that both coefficient of friction and Taber Abrasion and wear results are subject to variations of ± 15-20%, while the scratch tests will vary from ± 3-15% depending upon which test is run. NEMA tests run at 100 and 500 turns gave variations of 23

and 7%, respectively. Confidence limits of 95% were calculated for each series of test results and agreed closely with the observed data ranges.

The wide variations found in the tests themselves make it difficult to draw firm conclusions from the test data, which only show trends rather than positive results for most of the experimental series. In interpreting these data, variations in the CS-10 and CS-17 tests of less than 15% will be considered insignificant. Only Taber scratch variations greater than 5% will be considered significant; diamond threshold variations, only if greater than 15% for the resin flow and 10% for the resin tear test. NEMA variations will be considered significant at 20% and 10% for the 100 and 500 turn test, respectively. Values considered to have possible significance in indicating trends are underlined throughout the several tables.

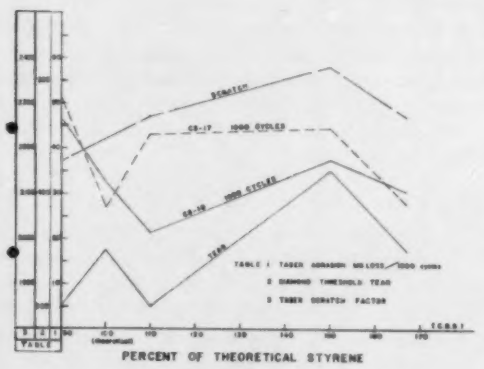


Fig. 1. Abrasion characteristics vs. styrene content.

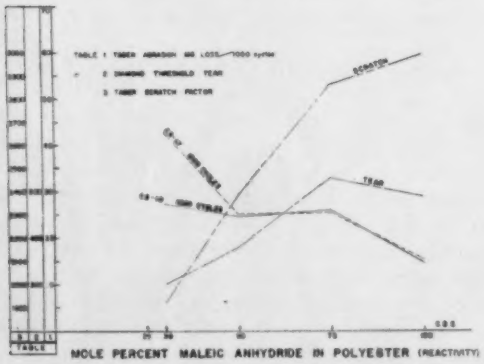


Fig. 2. Abrasion vs. resin reactivity.

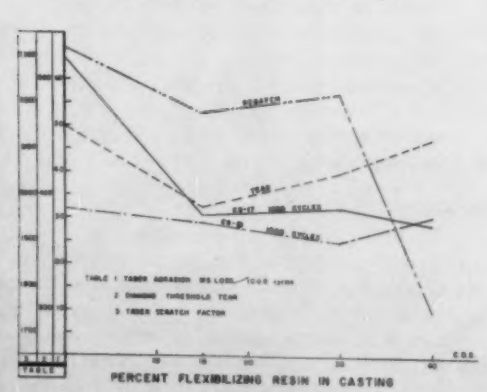


Fig. 3. Abrasion vs. rigidity.

Table 2 shows the effect of varying styrene content within the resin. Actual and theoretically-required styrene contents are included. Results are sufficiently variable so that it is difficult to pick out positive trends; however, it appears that less than theoretical monomer content may be undesirable. Most polyester resins contain considerably more than the required theoretical styrene content, and it would appear that minor variations are not extremely significant in changing the abrasion and wear properties of the resin. Figure 1 illustrates data spread and shows a very slight trend toward improved abrasion resistance with increased styrene content.

Resins with two different reactivities were investigated in the phthalic and isophthalic versions, and results are included in Table 3. Isophthalic resins appear superior to their phthalic counterparts in the CS-10 and CS-17 tests. The increase in hardness is due to the reactivity and composition of the resin, but the coefficient of friction variations are not explained. The Taber scratch hardness shows relatively little difference between the phthalic and isophthalic resins, with the phthalic being somewhat superior in scratch hardness. The diamond threshold flow results indicate that the phthalic resins may take somewhat more load before the surface resin is actually displaced, but the tear load is the same for both materials.

The resin reactivity data given in Table 4 indicates definite improvement in the wear, scratch, and threshold values as reactivity increases. The overall improvement in properties as reactivity increases is apparent in Figure 2. Table 5 variations include ultraviolet and post cures, accelerated resins, and paraffin wax addition. An extended, intermediate-temperature post cure showed considerable improvement in scratch hardness, improvement in CS-17 abrasion resistance, little change in CS-10 abrasion, and a drop in threshold values. Ultraviolet cures appear to give comparable results to a conventional heat cure, except in the threshold tear test.

Accelerator increased CS-17 abrasion resistance, but did not help the CS-10 or scratch performance, and actually reduced the threshold values. Efforts to obtain a "case hardened" surface by using an accelerator on the mold surface appeared successful, judging from the 500-turn CS-17 and scratch test results. Unfortunately, this improvement could not be verified by the threshold tests because accelerators cause surface irregularities. The abrasion and scratch properties of a wax containing resin surface were not significantly changed at the relatively low wax content of the specimen tested.

Hard, brittle materials frequently wear more rapidly than tough, yielding products. Although flexiblized resins scratch easier, they abrade less according to the data presented in Table 6. The degree of flexibility is apparent in the scratch test, but does not appear to be significant in the abrasion and threshold test.

Table 1.

Reproducibility of Test Data
(Five Specimens from One Panel)

Medium Reactivity Resin @ 35% Styrene Content, 1% Benzoyl Peroxide
Castings, Cure Gel @ 140° F + 1 hr. @ 170° F + 1 hr. @ 250° F
Molding Cure 3 min. @ 235° F

Specimen Number	Form	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss 1000/turns CS-10 wheels 1000 g. load 500 turns	Taber Abrasion, mg. loss 1000/turns CS-10 wheels 1000 g. load 1000 turns	Taber Abrasion, mg. loss 1000/turns CS-17 wheels 1000 g. load 500 turns	Taber Abrasion, mg. loss 1000/turns CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 g. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1	casting	112.0	45-50	23.6	22.4	32.4	34.6	2000	0.400	70	460
2	casting	112.2	47-51	28.2	31.6	33	25.8	1920	0.300	70	420
3	casting	112.6	48-51	32	32.2	24.2	29.4	1920	0.350	60	400
4	casting	112.4	47-51	32.4	30.3	35.8	36.1	1920	0.350	80	380
5	casting	112.4	45-50	21.4	31.8	24	30.6	2040	0.300	80	380
		Average		27.5	29.7	29.9	31.3	1960	0.340	72	408
		Range		11.0	9.8	11.8	10.3	120	0.100	20	80
		% ± Variation		20.0	16	20	17	3	15	14	10

Specimen Number	Form	NEMA Wheels 500 g. load 100 turns	NEMA Wheels 500 g. load 500 turns	100 turns	500 turns
6	molding	46.8	53.4	Avg. 61.4	55.7
7	molding	75.4	58.7	Range 28.6	8.0
8	molding	60.0	57.2	% ± 23	7
9	molding	64.5	58.3	Variation	
10	molding	60.5	50.7		

Table 2.

Styrene Variation
Medium Reactivity Resin
Castings Cure Gel @ 140° F + 1 hr. @ 170° F + 1 hr. @ 250° F 1% Benzoyl Peroxide

Specimen Number	Actual Styrene Content, %	Theoretical Required Styrene Content, %	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 500 turns	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 1000 turns	Taber Abrasion, mg. loss/1000 turns CS-17 wheels 1000 g. load 500 turns	Taber Abrasion, mg. loss/1000 turns CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 gm. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1	20.8	90	113.0	45-55	23.2	46.5	48.8	51.2	2170	0.388	80	300
2	22.5 (control)	100 (theoretical)	114	45-55	31.8	32.6	16.2	26.8	2220	0.275	70	350
3	24.0	110	113	50-55	25.6	21.4	64.2	43.2	2270	0.425	80	300
4	30.0	150	113	45-55	29.4	37.5	72.6	44.5	2380	0.325	100	420
5	32.5	167	113	50-60	27.4	30.5	14.4	27.7	2270	0.213	70	350

Table 3.

Phthalic vs. Isophthalic Resin
Castings, Cure = Gel @ 140° F + 1 hr. @ 170° F + 1 hr. @ 250° F

Specimen Number	Resin Component	Resin Reactivity	Styrene Content, %	Brookfield Viscosity, cps.	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 500 turns	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 1000 turns	Taber Abrasion, mg. loss/1000 turns CS-17 wheels 1000 g. load 500 turns	Taber Abrasion, mg. loss/1000 turns CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 gm. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1	phthalic anhydride	medium	25	3750	+105	40-50	24.4	24.4	26.6	31.2	2330	0.325	60	380
2	isophthalic acid	medium	28	2440	+105	40-50	17	18	7.0	27	2020	0.363	30	380
3	phthalic anhydride	medium high	28	2450	+114	50-60	27.6	27.7	24.6	32.3	2500	0.275	70	350
4	isophthalic acid	medium high	33	2220	+114	50-55	18.2	17.8	21.0	25.4	2180	0.475	50	350

Table 4.

Resin Reactivity
35% Styrene Content, 1% Benzoyl Peroxide
Castings, Cure = Gel @ 140° F + 1 hr. @ 170° F + 1 hr. @ 250° F

Specimen Number	Reactivity Mol % Maleic in Polyester	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 500 turns	CS-10 wheels 1000 g. load 1000 turns	CS-17 wheels 1000 g. load 500 turns	CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 gm. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1	low, 30%	M = +104	50-55	50.6	27.3	21.2	42.8	1920	0.525	60	300
2	medium, 50% (control)	M = +114	45-55	30.2	24.6	17.2	25.1	2380	0.350	60	380
3	medium 75% high	M = +114	55-60	20	25.9	42.2	25.5	2860	0.475	110	530
4	high, 100%	M = +112	50-60	26	14.7	8	15.5	2940	0.500	90	490

Table 5.

Additive, Accelerator and Cure Variation
Castings
Medium Reactivity Resin, 35% Styrene

Specimen Number	Additives	Catalyst and Accelerator	Cure	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 500 turns	CS-10 wheels 1000 g. load 1000 turns	CS-17 wheels 1000 g. load 500 turns	CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 g. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1 (control)	—	1% benzoyl peroxide	gel @ 140° F +1 hr. @ 170° F +1 hr. @ 250° F	112	45-55	31.8	32.1	59.2	65	2320	0.525	90	460
2	—	1% benzoyl peroxide	gel @ 140° F +1 hr. @ 170° F +1 hr. @ 250° F +15 hrs.@170° F	112	42-52	40.2	37.7	31	39.6	4750	0.383	70	410
3	—	1% benzoyl peroxide	4 hrs strong sun light	114	50-57	26.6	30.1	62.2	54.6	2180	0.313	80	390
4	—	1% benzoyl peroxide + 0.1% dimethyl aniline	gel @ 140° F +1 hr. @ 170° F +1 hr. @ 250° F	112	45-55	31.6	31.7	44.6	40.8	2440	0.225	70	410
5	—	1% benzoyl peroxide dimethyl aniline on mold surface	gel @ 140° F +1 hr. @ 170° F +1 hr. @ 250° F	113	45-48	35.4	40	15.4	34.7	2869	0.358	poor surface no test possible	
6	0.1% paraffin wax	1% benzoyl peroxide	gel @ 140° F +1 hr. @ 170° F +1 hr. @ 250° F	113	45-55	32.4	31.1	68	50.0	2320	0.325	80	410

Careful examination of Figure 3 will show the slight abrasion improvement, and loss in scratch factor is readily apparent.

Allyl resins and monomers offer improved abrasion resistance as indicated in Table 7. Theoretical quantities of styrene, allyl methacrylate, and diallyl itaconate all show improved abrasion properties as compared to a standard-styrene-content resin; the DAI showing the most improvement. The superior abrasion and scratch properties of 100% allyl resins are amply illustrated by the test results on allyl diglcol carbonate. This resin is recognized as one of the most abrasion resistant plastic materials, and the data established the magnitude of its superiority. It is interesting to note the improved scratch and threshold values in relation to the Rockwell M hardness. These are in direct opposition to the findings for resins softened by blending with flexible resins.

Cellulose-fiber surfacing plies are again shown equal or superior to other veil materials (See Table 8). Heavier resin surface layers are advantageous under most conditions, the exception being an acetate rayon fabric-reinforced surface. Here, poor results are probably caused by the woven fabric which gives lower resin content than do non-woven reinforcements. Solvent "polishing" of the rayon reinforced surfaces does little for the abrasion properties.

Table 9 shows pigmented, non-reinforced polyester

Table 6.

Flexibilized Resin

Rigid Resin, Medium Activity 35% Styrene
Flexible Resin, Medium Activity 30% Styrene (adipic)

Catalyst, 1% Benzoyl Peroxide
Castings, Cure = Gel @ 140° F + 1 hr. @ 170° F + 1 hr. @ 250° F

Specimen Number	Rigid Resin, %	Flexible Resin, %	Styrene Content, %	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 500 turns	CS-10 wheels 1000 g. load 1000 turns	CS-17 wheels 1000 g. load 500 turns	CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 g. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1	100	—	35.0	112	45-55	31.8	32	59.2	65	2320	0.525	90	460
2	85	15	34.3	108	40-50	30.2	29.1	14.6	30.8	2180	0.350	80	390
3	70	30	33.5	101	35-45	23.4	25	25.4	32.4	2220	0.225	70	420
4	55	45	33.0	91	35-45	30.4	30.6	20.6	28.9	1750	0.525	70	450

Table 7.

Monomer and Resin Variation
Medium Reactivity Polyester
Castings, Cure = Gel @ 140° F + 1 hr. @ 170° F + 1 hr. @ 250° F

Specimen Number	Components of Resin	Catalyst %	Rockwell M Hardness	Barcol Hardness	Taber Abrasion, mg. loss/1000 turns CS-10 wheels 1000 g. load 500 turns	CS-10 wheels 1000 g. load 1000 turns	CS-17 wheels 1000 g. load 500 turns	CS-17 wheels 1000 g. load 1000 turns	Scratch Factor 1000 g. load, g/mil x 100	Coefficient of Friction	Diamond Threshold Flow, g.	Diamond Threshold Tear, g.
1 (control)	Medium reactivity, 35% styrene	1% benzoyl peroxide	112	45-55	31.8	32.1	59.2	65	2320	0.525	90	460
2	Medium reactivity, 22.5% styrene	1% benzoyl peroxide	114	45-55	31.8	32.6	16.2	26.8	2220	0.275	70	350
3	Medium reactivity, polyester, allyl methacrylate 16%	1% benzoyl peroxide	102	45-55	29	32.5	37.8	34.7	2270	0.375	80	510
4	Medium reactivity, polyester, diallyl itaconate, 22.5%	1% benzoyl peroxide	109	55-65	18.4	21.7	12.4	28.2	2870	0.250	90	500
5	Allyl diglycol carbonate, 100%	3% isopropyl percarbonate gel @ 77° F 48 hrs. cure @ 115° F 76 hrs.	94	39-41	6.6	12.8	8.6	17.4	6660	0.325	150	850

surfaces to be disappointingly poor in abrasion resistance, and a plasticized overlay was even worse. Urethane and epoxy coatings evidenced excellent surface characteristics, the baked epoxy being outstanding in the Taber and threshold tests. Both urethane and epoxy threshold values appeared to be somewhat contradictory, with a wide spread between flow and tear values. High NEMA losses for the baked acrylic coating were somewhat unexpected in view of the Taber results, but are in line with the poor scratch values.

Melamine-surfaced phenolic again proves its right to the lead position in the field, being superior to all other surfaces studied except for the long baked epoxy coating. The outstanding example of an abrasion resistant product is the polyester film, Videne. The Videne-covered panel available for test was small, and all the tests could not be run.

The poor scratch and threshold values, coupled with the outstanding CS-10 abrasion losses, further show the abrasion resistance of a truly tough surface. Wax in a molded resin surface shows no more promise than it does in a cast resin.

The Table 10 data on benzoyl peroxide-cured panels show the cure time to be of little importance beyond 1½ minutes. An accelerator may be of some help, although the degree of improvement is not clear cut. Slower cures and inferior surfaced products are apparent with DDM and cumene hydroperoxide catalysts, and mixed catalyst systems do not offer appreciable improvement in abrasion characteristics. Stick with benzoyl for cure rate and properties.

Fillers may affect surface properties (See Table 11), however, no clearly defined trends were observed. Increased wet-out or soaked time may help the abrasion characteristics somewhat, although improvement seems to be minor and variable. Extra binder on the mat

Table 8.

High Resin Content Reinforced Surface
Medium Reactivity Resin

Molding
35% Styrene, 1% Benzoyl Peroxide, Cure 3 min. @ 235° F

Specimen Number	Surface Reinforcing	Taber Abrasion, mg. loss/1000 turns: CS-10 wheels, 1000 g. load: 500 turns	1000 turns	CS-17 wheels, 1000 g. load: 500 turns	1000 turns	Scratch Factor 1000 g. load, g/mil x 100	NEMA Wheels 500 g. load: 100 turns, mg. loss	500 turns, mg. loss	Diamond Threshold: Flow, g.	Tear, g.
1 (control)	No veil	48	47.4	62.4	62.7	1750	56.7	67.4	140	270
2	OCF 15 mil veil	33.2	44.0	49.8	46.6	2220	46.5	56.6	130	230
3	OCF 30 mil veil	42.8	41.9	35.8	42	2320	44.9	49.9	130	220
4	Modigliani (Modiglass)	45.8	41.9	42	45.6	2380	51.3	56.1	120	260
5	Cellulos fiber tissue (Kimwipe)	41.8	39.6	40	43	2220	43.1	43.6	150	240
6	Dacron veil	45.8	52.7	32.4	41.5	2080	76.5	69.6	120	260
7	Nylon veil	48.6	50.6	48.3	54.1	1961	69.9	67.4	120	240
8	Acetate rayon fabric	44.2	42.7	71.4	67.5	2041	10.9	107.2	80	250
9	Acetate rayon fabric, solvent dipped	47.2	42	48.2	71.3	2439	177	115	80	300

Table 9.

Overlays and Coatings

Specimen Number	Overlay or Coating Type	Application Technique	Taber Abrasion, mg. loss/1000 turns: CS-10 wheels, 1000 g. load: 500 turns	1000 turns	CS-17 wheels, 1000 g. load: 500 turns	1000 turns	Scratch Factor 1000 g. load, g/mil x 100	NEMA Wheels 500 g. load: 100 turns, mg. loss	500 turns, mg. loss	Diamond Threshold: Flow, g.	Tear, g.
1	None (control)	Medium reactivity resin 1% benzoyl peroxide, cure 3 min. @ 235° F	48	47.4	62.4	62.7	1750	56.7	67.4	140	270
2	Pigmented polyester overlay	Sprayed on cold mold, gel @ 77° F, 3 min. @ 235° F	77.2	69.4	73	76.9	2040	96.3	98.3	70	220
3	Pigmented polyester overlay	Sprayed on hot mold gel @ 235° F, cured 3 min. @ 235° F	83.8	75	61.8	56.4	2380	129.3	107.2	70	400
4	Pigmented polyester overlay + 10% tricresyl phosphate	Sprayed on hot mold, gel @ 235° F, cured 3 min. @ 235° F	102.4	94.2	73.6	66.8	1490	180.3	148.5	70	300
5	Urethane coating	Painted on panel, air dry @ 77° F	19.8	21.8	26.6	30.8	2220	51.8	60.8	40	350
6	Acrylic coating	Sprayed on panel, baked 30 min. @ 300° F	32.0	50.4	67.9	37.5	1610	91.7	81.5	120	260
7	Epoxy coating	Sprayed on panel, cured 3 hrs. @ 250° F + 1 hr. @ 300° F	12.8	11.9	10.6	7.7	2940	60.1	60.4	80	860
8	Melamine (Formica)	Standard laminating procedure	19.0	15.0	10.4	10.8	2560	62.0	51.3	170	350
9	Videne A, polyester film	Film adhered to panel	6.0	8.7	—	—	1490	—	—	60	160
10	Wax in resin	——	52.6	49.3	41.6	42.7	2080	82.6	66.4	120	260

Table 10.

Catalyst and Cure Variation
Medium Reactivity Resin
Molding, 35% Styrene, Cure @ 235° F

Specimen Number	Catalyst Content	Cure Cycle	Taber Abrasion, mg. loss/1000 turns, CS-10 wheels, 1000 g. load, 500 turns	Taber Abrasion, mg. loss/1000 turns, CS-10 wheels, 1000 g. load, 1000 turns	Taber Abrasion, mg. loss/1000 turns, CS-17 wheels, 1000 g. load, 500 turns	Taber Abrasion, mg. loss/1000 turns, CS-17 wheels, 1000 g. load, 1000 turns	Scratch Factor 1000 g. load, g/mil x 100	NEMA Wheels 500 g. load, 100 turns, mg. loss	NEMA Wheels 500 g. load, 500 turns, mg. loss	Diamond Threshold, Flow, g.	Diamond Threshold, Tear, g.
1	1% benzoyl peroxide	3 minutes	48	47.4	62.4	62.7	175	56.7	67.4	140	270
2	1% benzoyl peroxide	1.5 minutes	49.2	46.1	65	61.7	1820	61.0	66.4	140	280
3	1% benzoyl peroxide +0.1% dimethyl aniline	1.5 minutes	52.6	49.3	41.6	42.7	2080	82	66.4	120	260
4	2% DDM (MEK peroxide)	6 minutes	57.4	50.0	61.2	64.8	2000	84	71.8	120	270
5	2% DDM (MEK peroxide)	3 minutes	60.4	52.6	67.8	83.3	1850	75	72.8	170	320
6	2% cumene hydroperoxide	6 minutes	52.6	46.8	75.6	81.8	1235	117	96.9	170	250
7	2% cumene hydroperoxide	3 minutes	61.6	60.0	118.0	112.0	1330	110	94.0	120	330
8	0.5% benzoyl peroxide 1% cumene hydroperoxide	6 minutes	31.4	48.3	40.2	57.6	1960	79.2	64.9	130	300
9	0.5% benzoyl peroxide 1% cumene hydroperoxide	3 minutes	62.6	53.2	63.4	73.1	1820	85.2	74.1	120	260
10	0.5% benzoyl peroxide 0.5% DDM	6 minutes	52.2	45.7	31.8	47.9	1890	58.1	66.2	170	280
11	0.5% benzoyl peroxide 0.5% DDM	3 minutes	58.4	55.5	62.4	68.3	2000	113	69.3	140	280

Table 11.

Filler Addition, Wet Out Time and Mat Binder Variation
Medium Reactivity Resin
35% Styrene Content, 1% Benzoyl Peroxide
Molding, Cured 3 min. @ 235° F

Specimen Number	Filler Content	Binder Content	Wet Out Time Before Molding	Taber Abrasion, mg. loss/1000 turns, CS-10 wheels, 1000 g. load, 500 turns	Taber Abrasion, mg. loss/1000 turns, CS-10 wheels, 1000 g. load, 1000 turns	Taber Abrasion, mg. loss/1000 turns, CS-17 wheels, 1000 g. load, 500 turns	Taber Abrasion, mg. loss/1000 turns, CS-17 wheels, 1000 g. load, 1000 turns	Scratch Factor 1000 g. load, g/mil x 100	NEMA Wheels 500 g. load, 100 turns, mg. loss	NEMA Wheels 500 g. load, 500 turns, mg. loss	Diamond Threshold, Flow, g.	Diamond Threshold, Tear, g.
1 (control)	None	Normal	Normal	48	47.4	62.4	62.7	1750	56.7	67.4	140	270
2	10 parts Surfex MM/100 parts resin	Normal	Normal	48.8	46.0	39.2	41.0	2080	64.5	69.0	70	240
3	30 parts Surfex MM/100 parts resin	Normal	Normal	60.2	55.2	52.2	55.1	2270	86.5	69.0	140	250
4	None	Normal	5 minutes	44.2	45.4	55.6	61.7	1890	83.6	68.1	160	220
5	None	Normal	20 minutes	44.8	41.0	42.8	50.1	2040	77.8	73.0	110	250
6	None	Normal	60 minutes	52.2	52.8	46.4	46.6	2440	69.9	67.6	110	230
7	None	4% extra	Normal	56.8	50.0	47.4	45.9	2500	99.9	86.0	170	300
8	None	8% extra	Normal	42.0	47.2	51.6	53.1	2500	93.8	81.3	150	350

should have little influence on the surface properties, although the CS-17 and scratch did appear to show improvement while the NEMA results were poor. Definite conclusions are difficult to draw from the data in this table.

The higher number of turns in the abrasion tests seems to give a greater uniformity of results but, because of the depth and amount of wear involved in the longer running tests, the results may not be a direct indication of expected service life. The CS-17 wheels appear to show more variation between specimens, and would probably be more suitable than the CS-10

Table 12.
"Proof Resins" Reinforced

Specimen Number	Composition	Monomer Type	Monomer Content %	Catalyst Type	Catalyst Content %	Taber Abrasion Mg. loss/1000 turns 1000 g. load 1000 turns CS-10	Taber Abrasion Mg. loss/1000 turns 1000 g. load 1000 turns CS-17	NEMA Wheels 500 g. load 500 t. mg. loss	Reinforcement	Cure
1 Control previous molding	medium reactivity	styrene	34	benzoyl peroxide	1	48	62	67	2 plies 219 mat	3 min. @ 235° F
1a Control current molding	medium reactivity	styrene	34	benzoyl peroxide	1	60	44	62	2 plies 219 mat	3 min. @ 235° F 3 hrs. @ 250° F P.C.
2	maleic (3) IPA (1) dipropylene	styrene	37	benzoyl peroxide	1	46	51	66	2 plies 219 mat	3 min. @ 235° F 3 hrs. @ 250° F P.C.
3	maleic (3) IPA (1) dipropylene	DAP	35	benzoyl peroxide	1	39	59	61	2 plies 219 mat	3 min. @ 235° F 3 hrs. @ 250° F P.C.
4	maleic (3) IPA (1) dipropylene	DAI	35	benzoyl peroxide	1	37	31	48	2 plies 219 mat	5 min. @ 235° F 3 hrs. @ 250° F P.C.
5	Epoxy 828	—	—	TETA	10	12	10	45	2 plies 219 mat	30 min. @ 235° F 3 hrs. @ 250° F P.C.
6	low reactivity	styrene	35	DDM	1	—	—	84	—	gel @ room temp. 1 hr. @ 170° F 1 hr. @ 250° F
7	low reactivity room temp. resin	styrene	35	DDM	1	—	—	85	mohair coarse vertical	gel @ room temp. 1 hr. @ 170° F 1 hr. @ 250° F
8	low reactivity room temp. resin	styrene	35	DDM	1	—	—	77	mohair fine vertical	gel @ room temp. 1 hr. @ 170° F 1 hr. @ 250° F
9	low reactivity room temp. resin	styrene	35	DDM	1	—	—	68	mohair coarse horizontal	gel @ room temp. 1 hr. @ 170° F 1 hr. @ 250° F
10	low reactivity room temp. resin	styrene	35	DDM	1	—	—	53	mohair fine horizontal	gel @ room temp. 1 hr. @ 170° F 1 hr. @ 250° F

wheels for evaluation and comparison of new resins. The uniformity of the NEMA tests and the ability of this test to indicate the difference between panels make it a desirable evaluation procedure.

The agreement between abrasion, scratch, and threshold tests was poor; in fact, could almost be said to be non-existent throughout the data reported in this paper. It is interesting to note, however, that the flow value is higher and tear value lower on the average for the rapid-cure molded panels in comparison with the more slowly cured, cast surfaces. The coefficient of friction appears of little help in evaluating the abrasion resistance of resin surfaces. Thus, the data do not show a non-abrasive test to be acceptable as a method of indicating abrasion or wear resistance.

Conclusions

Since many of the above conclusions were based on the slimmest of trend indications, it is proposed that additional panels be prepared and tested to check out the conclusions drawn thus far. It would appear that a resin with a relatively high activity, isophthalic acid, a diglycol for flexibility, and an allyl monomer should give superior abrasion resistance when cured with benzoyl peroxide at 235° F. A reinforced overlay would also be desirable.

PROOF EXPERIMENT. The "proof experiment" proposed in the preceding paragraph was carried out using a dipropylene 75:25 maleic isophthalic polyester. The polyester was thinned with styrene, DAP, and DAI in three separate versions. Two-ply laminates were prepared with the 1% benzoyl peroxide catalyzed resin and 2-ounce #219 mat. These laminates were cured 3 minutes at 235° F. in the mold, and then were given an additional 3-hour postcure at 250° F. in a circulating air oven. A similar epoxy 828 laminate catalyzed with TETA was also prepared using a 30-minute cure in

(Continued on page 56)

Photo by: Fabian Bachrach

Wollastonite*—

an extender for polystyrene

PETER VIRTUE**

The polystyrene industry has become very competitive. This is due, at least in part, to the large volume markets and applications which have developed, and to the relatively large number of basic producers and fabricators competing for these markets and applications. The result—a gradual lowering of prices and profit margins. When this same situation became apparent in the thermosetting plastic field, extenders were incorporated to reduce costs. These extenders, or fillers, consist of a series of relatively low priced pigments which can be incorporated into a compound to lower the raw material cost of a finished product, yet not impair product quality. Extenders appear much easier to use in thermosetting systems than with thermoplastics.

There have been many attempts to find a suitable extender for polystyrene and, until recently, all have failed. This is probably due to poor wetting characteristics. The surface of the pigment particles is not attractive enough to the polymer surrounding it to form a compatible system. We know, that when a pigment is incorporated into polystyrene in excess of 3% by weight, a significant degradation of physical properties, tensile strength, elongation, and modulus begins. This factor has prevented extensive use of fillers in polystyrene until recently.

I would like to submit for your evaluation, data on a filler or extender pigment for polystyrene. This pigment does not diminish polystyrene's physical properties when used in the amounts necessary to effect substantial cost savings.

The material is wollastonite, a naturally occurring mineral form of calcium metasilicate, mined and processed by Cabot Corp. It is supplied as a white powder, and is currently being used as an extender for paints and thermosetting plastics, and as a basic ingredient in the manufacture of ceramics. It is chemically inert and has an acicular particle shape. Physical and chemical characteristics are shown in Table 1.

Table 1. Properties of Wollastonite P-4

Chemical formula	$CaSiO_3$
Crystalline structure	acicular
Specific gravity	2.9
Coefficient of expansion (mm/mm° C.)	6.5×10^{-6}
Refractive index	1.63
Melting point (° C.)	1540
Solubility in H_2O (gm/100 cc)	0.0095
Hardness (Mohs' Scale)	4.5
Color	brilliant white
Weight (lbs./solid gallon)	24.2
Bulking value (gal./lb.)	0.0413
Average particle size (microns)	2.8

Table 2. Typical Physical Properties of Wollastonite-Filled General Purpose Polystyrene

Weight Percent Wollastonite	0	10	20	30
Tensile strength at failure (psi)	8344	8585	8621	8138
Elongation at failure (%)	2.3	3.2	3.3	2.7
Izod impact strength Dead end — ½ x ½" bar Ft. lbs. per inch of notch	0.38	0.35	0.37	0.28
Density (lbs./cu. ft.)	65.6	69.9	75.2	81.0
Flexural strength at failure (½ x ¼ x 3 in. bar) lbs.	56.3	62.0	—	61.1
Surface gloss (low angle)	100	77	76	69

What happens when wollastonite is mixed into general purpose polystyrene? All evidence shows that there is essentially no degrading effect on physical properties brought about by the incorporation of up to 30% by

* Now tradenamed Cabolite

** Tech. Service Rep., Minerals & Chemicals Div., Cabot Corp., New Brunswick, N. J.

weight of this filler. Table 2 points out the typical strength characteristics of wollastonite-filled polystyrene. Each figure is an average of a number of tests run on several compounds, some by us and some reported to us by other concerns.

As you might expect, the incorporation of such high loadings of a pigment like wollastonite reduces the surface gloss of a filled piece, thus producing a matte finish. There are certain applications which require a slick, hard surface gloss. In many cases, however, a matte effect gives the piece a certain richness of appearance not otherwise attainable.

We have not yet evaluated compounds containing more than 30% wollastonite. This does not mean, however, that it is not feasible. In applications where the highest tensile and flex strengths are not absolutely essential, it is conceivable that 50% and even higher loadings might be considered.

The increase in product density with wollastonite loadings is important. Wollastonite has a specific gravity of approximately 2.9; polystyrene, about 1.05. Therefore, the greater the amount of wollastonite added, the greater the density or weight of the finished piece. The weight of a cubic foot of straight polystyrene increases from 65.6 pounds to 81 pounds with 30% added wollastonite. This increase in weight gives "heft" or substance to consumer goods..

Cost advantages

The main advantage in extending polystyrene is the cost savings which result. Wollastonite P-4 costs less than 2½ cents per pound, delivered, whereas polystyrene runs about 18 cents. The more extender used, the lower the raw material cost of the finished item. Table 3 shows the relationship between the weight per

Table 3. Raw Materials Costs

General Purpose Polystyrene ..... $0.18/lb.
Wollastonite P-4 ..... 0.02/lb.

Percent Wollastonite (by wt.)	Cost ($/cu. ft.)	Approx. Savings % (Volume basis)
0	11.81	0
10	11.50	2.6
20	11.14	5.7
30	10.72	9.2

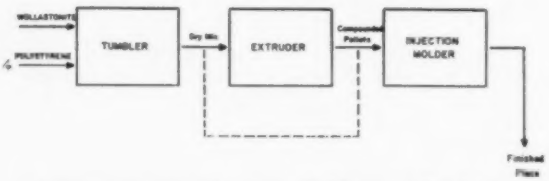
cent wollastonite in the compound and the raw material cost of the product; both on a weight basis and, more significantly, on a volume basis. The weight basis savings are much higher because of the increase in density effected by the addition of the heavier filler. Volume savings actually mean more, since a molded piece, regardless of material, must always displace the same volume. To estimate the savings this can mean to you, multiply your daily consumption of polystyrene in pounds by 1⅔ cents (your actual per pound saving). This can make a big difference in a competitive market.

Process techniques

It is important to know all of the costs involved in using wollastonite. Essentially, no additional processing is necessary for its incorporation into a product by the molder. Our initial evaluations were made by dispersing wollastonite into polystyrene on a two-roll rubber mill or Banbury mixer. The pigment seemed to wet-out and disperse so easily on this equipment, we decided to try simpler compounding techniques.

We tumbled wollastonite together with crystal pellets in a rotating drum, transferred the dry-mix to an extruder, and extruded new pellets. Enough dispersion was effected so that the compounded pellets could be used in injection molding. In this operation, the molded piece had essentially all the properties of the compound mixed on the high-shear, two-roll or Banbury mill. Where gloss uniformity and homogeneous surface appearance are not essential, we found that a dry mix of wollastonite and powdered polystyrene could be fed directly into the injection molding machine and produce a satisfactory product. There is no difference in physical properties, only surface appearance. Table 4 schematically depicts the mixing process which we recommend.

Table 4. Dispersing Technique



As you can see, the use of this extender in your compound requires little or no addition of processing equipment. What, then, are the limiting factors? First, filled polystyrene obviously cannot be used in any application where clarity or transparency is required. Also, it cannot be used where high surface gloss is essential. On the other hand, what are the principal applications? Industrial parts and children's toys offer outstanding possibilities. Too, there has been some interest in a matte finish wall tile.

Conclusion

Wollastonite appears an excellent extender for general purpose polystyrene. Its physical characteristics in finished form have been covered and the extent of possible savings to be gained from its use. We do not, as yet, know exactly why wollastonite behaves so differently from other pigments when added to polystyrene. Limited data indicates a very deteriorating effect on high-impact styrenes. Perhaps this is a clue. Further study will undoubtedly yield the answer as to why it works, as well as to many other questions. —THE END

Considering the highly competitive picture found in injection molding today, here's a chance to cut material costs by 1⅔ cents per pound in general purpose polystyrene. Remember, however, you can't get clarity or a high gloss finish. There has been a natural reluctance on the part of polystyrene processors to fear pigment loading, but this article points out the fact that wollastonite reacts quite differently.—Editor.

Four epoxy plasticizers

Performance and compatibility data are given for four epoxy plasticizers; three secondary, and one primary. One of the epoxidized soybean oils can be used as an inexpensive extender for epoxy resins, allowing increased loadings of pigments or fillers.—Editor

E. W. LINES*

Vinyl compounds are composed generally of resin, primary plasticizers (such as esters of phthalic anhydride and alcohols), epoxy plasticizers, and metallic stabilizers. The primary plasticizers aid in softening the resin, aid in resin processing, and add a permanent flexibilizing action to finished goods. Carbide's Flexol** DOP [di(2-ethylhexyl) phthalate] is a commonly used primary plasticizer of this type, and is generally used at a 10-100 PHR level.

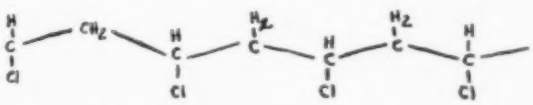
The epoxy plasticizers such as Flexols EPO, JPO, EP-8, and PEP, used at stabilizing levels of 5-10 PHR and plasticizing levels of 15-60 PHR, serve a dual function: heat and light stabilization; and offer additional plasticizing efficiency to the primary plasticizers. Epoxies augment the metal stabilizers by the synergistic stabilizing action of the combination, and make possible the production of clear films.

The common primary plasticizers are derived from aromatic ring structures and combine with alcohols to form liquid, water-clear products which are compatible with vinyl resins. The epoxy plasticizers are commonly produced by epoxidation of soybean oil or alcohol tallate esters. They are not as compatible with vinyl as are primary plasticizers, but exhibit adequate compatibility in the dual role of plasticizing and stabilizing in combination with the primaries.

The metallic stabilizers are generally barium, cadmium, lead, and zinc salts of organic acids. All these components are compounded with vinyl resins to form a mixture that is easily processed into calendered goods such as furniture, automotive, and wall coverings; molded goods such as dishes, toys, and automotive trim; and extruded goods such as film, seat covers, window coverings, tablecloths, garden hose, and electrical wire insulation.

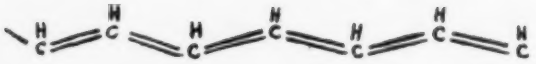
Epoxy stabilizers act as transfer agents for hydrochloric acid released from PVC resins during the heat of processing. The oxirane ring is extremely susceptible to ring opening by HCl to form the corresponding chlorohydrin. The metallic salts then react with the chlorohydrin forming the corresponding metal chloride and effect closure of the oxirane ring.

The action of heat and light encountered during the processing and useful life of vinyl products often causes changes in color and physical properties. In order to understand the basic principles of stabilization, the mechanism of degradation should be understood. The general structure of polyvinyl chloride has been shown as:



Heating PVC resins at 80° C., and above, will produce a series of color changes ranging initially from light yellow through dark yellow, orange, and ultimately to reddish brown and black. The release of HCl during this reaction suggests that a degraded polymer has resulted, yielding the approximate following poly(ene) structure:

* New Chemicals Div., Union Carbide Chemicals Co., New York, N. Y.
** Trademark of Union Carbide Chemicals Co.



Presence of this unsaturated structure has been confirmed by light absorption studies, and is indicative of color formation. The release of HCl and formation of these unsaturates promote the reaction step-by-step along the chain. Spectral studies also indicate polyene oxidation as shown by the presence of carbonyl groupings.

Epoxidize soybean oils

Flexols EPO and JPO are new, high-purity epoxidized soybean oils produced from peracetic acid for use as plasticizers and effective, low-cost, heat and light stabilizers for vinyl chloride polymers. They impart excellent resistance to extraction by oil and water and have low volatility.

The high oxirane oxygen content and low residual unsaturation of EPO assures maximum compatibility and stabilization. Generally, 2-7 PHR will be used for stabilizing purposes where little or no plasticizing action is required. Its use with metallic stabilizers improves both the initial and ultimate stability of the compound, at the same time cutting costs through reduction in the amounts of more expensive metallic stabilizer required. When used as a dual plasticizer-stabilizer, the concentration of Flexol EPO may represent 10-15% of the total.

Flexol JPO's low cost makes it ideal for use in vinyl floor tile, extruded stock, and molded articles. Other application areas include vinyl electrical insulation, coated fabrics, gaskets, and foamed articles. It is suggested as a stabilizer for chlorinated solvents, chlorinated rubber, and nitrocellulose coatings.

Well adapted to plastisol and organosol compounding, it offers good compatibility, excellent plasticizing action, low viscosity, and stability. JPO is also an excellent dispersing medium, and can be used very satisfactorily as a base for incorporating pigments. Conventional milling equipment such as roller or ball type mills can be used. The following data illustrates its viscosity stabilizing performance in plastisols and organosols:

Formulation QYNV resin—100 parts
Flexol JPO—60 parts

	Viscosity stability, 70° F. Aging		
	24 hours	7 days	SPI Test Method
Brookfield, RVF, Spindle #6	poises	poises	
At 2 RPM	330	330	SPI-VD-T1
At 20 RPM	334	312	
Extrusion Rheometer			
At 0.157 psi.	360	502	SPI-VD-T2
At 2.19 psi.	736	899	

Extender for epoxy resins

JPO represents an economical approach to the modification of conventional epoxy resins by viscosity reduction and replacement pound-per-pound with a lower cost material. It offers an opportunity to expand the wide range of chemical and physical properties of base epoxy resin, and allows increased loadings of various pigments and fillers. The epoxide group is reactive with acidic epoxy hardeners and catalysts, but less reactive with basic amines.

Typical Analysis of Flexols EPO and JPO

	EPO	JPO
Total epoxide (oxirane oxygen), min.	6.8	6.4
Iodine value	0.9	2.2
Acidity, as acetic acid	0.07	0.07
Water content, %	0.04	0.04
Color, Pt-Co	60	100-150
Viscosity at 100° F., cks.	188	162
Specific gravity at 20/20° C.	0.9956	0.990
Flux temp., min., ° C.*	125	123

* Based on 50 pts. QYNV, 50 pts. plasticizer, and 0.5 pts. Stabilizer D-22

Compatibility

	Concentration—Resin: Plasticizer					
	9:1		4:1		1:1	
	EPO	JPO	EPO	JPO	EPO	JPO
Polyvinyl acetate	VSI		SI		I	
Polyvinyl butyral	C		C		I	
Polyvinyl chloride	C		C		I	
Vinyl chloride-vinyl acetate copolymer (VYHH)	C		C		C	
Cellulose acetate	I		I		I	
Cellulose acetate butyrate						
17% Butyryl content	I		I		I	
37% Butyryl content	C		C		C	
Nitrocellulose	C		C		C	
Ethyl cellulose	C		C		C	
Methyl methacrylate	I		I		I	
Polystyrene	I		I		I	
Chlorinated rubber	C		C		C	

C—Compatible I—Incompatible SI—Slightly incompatible
VSI—Very slightly incompatible

Epoxidized tallate esters of 8-carbon alcohols

Tallate and stearate esters of alcohols are used where lower temperature flexibility is required—lower than that possible with epoxidized soybean oils. Carbide's entry is Flexol EP-8 (epoxy 2-ethyl hexyl tallate), which can be used as a low-temperature plasticizer in place of the more-expensive azelate, adipate, and sebacate plasticizers; and in addition, as an epoxy stabilizer.

EP-8 has a low specific gravity and, therefore, a low volume cost. Its plasticizing efficiency is comparable to the commonly used phthalates such as DOP, but its volatility is considerably less. Both viscosity and solvating power are low. As a result, plastisols incorporating EP-8 are characterized by low viscosity and viscosity stability. It is also effective in reducing the dilatancy problem of plastisols used in high-speed coating operations, and vinyl film and sheeting will have good hand and drape.

We suggest that EP-8 be used in combination with more compatible primary plasticizers such as DOP in concentrations up to one half of total plasticizer, depending on the degree of low-temperature flexibility required. Generally, 5-25 PHR should be used.

Performance in Vinyl Films

Performance Properties	Concentration of Epoxy Plasticizer, PHR								"FLEXOL" DOP at 50 PHR	Test Methods
	40		50		70		60	53		
	EPO	JPO	EPO	JPO	EPO	JPO	EPO	JPO		
Durometer A Hardness	89	89	81	82	67	68	80	80	79	ASTM D-676
Stiffness at 23° C, psi	7000	6300	2200	2200	750	750	1900	1800	1900	D-747
0° C, psi	125000	84500	46000	36000	4800	1200	15000	24000	19000	D-1043
T_4, C °[a]	21	20	10	11	—5	—8	2	8	7	D-747 and D-1043
Brittle Temperature[b]	—10	—8	—16	—17	—26	—26	—17	—19	—24	D-746
Loss from 0.004-in. film:										
SPI Volatile Loss (24 Hrs. at 70° C) %	0.4	0.1	0.7	0.2	0.8	0.2	0.7	0.2	1.0	
Water Extraction (24 Hrs. at 70° C) %	0.4	0	0.5	0	0.7	0	0.6	0	0.5	
Oil Extraction (50° C, K)[c]	0.3	0.4	0.8	0.9	2.0	2.5	0.8	1.0	1.9	
Marring 1 psi, 40° C, 24 hrs.										
Nitrocellulose	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Polystyrene	None	None	None	None	None	None	None	None	Yes	
Spew, 1 week						Dry				
60° C, 100% R. H.	None	Yes	None	Yes	Yes	Exud	None	Yes	None	
Room Conditions	None	None	None	None	None	None	None	None	None	
RS-Sunlamp	None	None	None	None	None	None	None	None	None	

Formulation:

Bakelite vinyl resin QYTQ	100 parts
"Dyphos" stabilizer	2 parts
DS-207	1 part
FLEXOL plasticizer	as shown

(a) T_4 is the temperature at which a vinyl compound has a torsional stiffness of 10,000 pounds per square inch.
(b) Method Used: A.S.T.M. d-746-52T
(c) $K = \frac{\text{Loss (grams/square meter)}}{\sqrt{\text{Time (hr.)}}}$

Flexol EP-8 Performance in Vinyl Films

Performance Properties	Concentration of FLEXOL EP-8, PHR			FLEXOL DOP at 50 PHR	Test Method
	40	50	70		
Durometer A Hardness	88	80	70	79	ASTM D-676
Stiffness at 23° C, psi	3200	1500	820	1900	ASTM D-747
T_4, ° C[a]	6	—6	—27	7	ASTM D-747 & D-1043
Brittle Temperature, ° C[b]	—38	—42	—56	—24	ASTM D-746
Loss from 0.004-in. film:					
Volatile Loss (24 hrs. at 70° C), %	2.0	2.4	4.8	1.0	
Water Extraction (24 hrs. at 70° C), %	1	1	1	0.5	
Oil Extraction (50° C, K)[c]	2.6	5.2	10.8	1.9	
Spew, 2 Weeks					
100% Rel. Humidity, 60° C	yes	yes	yes	none	
Room Conditions	none	none	none	none	

Formulation:

Bakelite vinyl resin QYTQ	100 parts
"Dyphos" stabilizer	2 parts
DS-207	1 part
FLEXOL plasticizer	as shown

(a) T_4 is the temperature at which a vinyl compound has a torsional stiffness of 10,000 pounds per square inch.
(b) Method Used: A.S.T.M. D-746-52T
(c) $K = \frac{\text{Loss (grams/square meter)}}{\sqrt{\text{Time (hr.)}}}$

Performance in 75 PHR Plastisols at 70° F.

	Brookfield Viscosity, poises					
	2 RPM Spindle speed			20 RPM Spindle speed		
	16 Hour Aging	7 Day Aging	14 Day Aging	16 Hour Aging	7 Day Aging	14 Day Aging
Flexol EP-8	22	25	26	14	17	18
Flexol DOP	60	90	100	45	67	72
Flexol 10-10	42	55	57	39	50	52

Plastisol Formulation: Geon 121 100 parts
Plasticizer 75 parts

Minimum Flux Temperature*
Flexol EP-8 125° C.
Flexol DOP 106° C.

* Minimum fluxing temperature measured in composition of 50 parts Bakelite vinyl resin QYNV, 50 parts plasticizer, and 0.5 part Stabilizer D-22.

Typical Analysis of EP-8

Oxirane oxygen, by wt.	5.1
Iodine value	1.5
Acidity, as acetic acid, % by wt.	0.08
Color, Pt-Co	60
Viscosity, 25° C., cps.	28-30
Specific gravity	0.916-0.920

Compatibility

	Concentration—Resin: Plasticizer		
	9:1	4:1	1:1
Polyvinyl acetate	I	I	I
Polyvinyl butyral	C	C	I
Polyvinyl chloride	C	C	I
Vinyl chloride-vinyl acetate copolymer (VYHH)	C	C	C
Cellulose acetate	I	I	I
Cellulose acetate butyrate			
17% Butyryl content	SI	SI	I
37% Butyryl content	C	C	C
Nitrocellulose	C	C	C
Ethyl cellulose	C	C	C
Methyl methacrylate	SI	I	I
Polystyrene	C	C	C
Chlorinated rubber	C	C	C

C—Compatible I—Incompatible SI—Slightly incompatible

Primary epoxy stabilizer

The fourth epoxy plasticizer-stabilizer, Flexol PEP, offers a new approach to vinyl plasticizing and stabilization. It combines the compatibility and plasticizing attributes of a primary plasticizer with the stabilizing and plasticizing action of epoxy systems. This permits the vinyl processor to combine plasticizer and stabilizer requirements into two products, PEP and metal stabilizers.

In addition, Flexol PEP opens up new markets by imparting fungus resistance to vinyl goods, and by permitting the use of vinyl for such outdoor applications as coatings for aluminum house siding, industrial maintenance coatings, greenhouse and silage covers, and pond liners.

PEP is a general-purpose primary plasticizer with plasticizing properties and structure similar to diiso-decyl phthalate. Chemically, it is di(iso-decyl) 4,5-epoxy tetrahydrophthalate. It is less volatile and more resistant to extraction by oil than is DIDP. When used as an epoxy-type heat and light stabilizer, a concentration of 5-15 PHR should be tried initially. Suggested applications include agricultural film and sheeting, electrical insulation, automotive and furniture upholstery, extrusions, flooring, and coatings.

Typical Analysis of Flexol PEP

Molecular weight	446
Specific gravity at 20/20° C.	0.983
Absolute viscosity at 20° C., cps.	184
Oxirane oxygen, % by wt.	3.0
Iodine value	1.0
Acidity, as acetic acid, % by wt.	0.07
Color, Pt-Co	200
Refractive index at 20° C.	1.4678

Compatibility
Two weeks aging

	Room conditions			100% Relative Humidity @ 60° C.			R.S. Sunlamp		
Plasticizer concentration	40	50	70	40	50	70	40	50	70
Flexol PEP	OK	OK	OK	OK	OK	OK	OK	OK	OK
Epoxidized soybean oil	OK	OK	OK	S.O.	S.O.	S.O.	OK	OK	OK
Alkyl epoxy stearate	OK	OK	OK	S.O.	S.O.	S.O.	OK	S.O.	S.O

Formulation: Bakelite vinyl resin VYNW 100 parts
Dyphos Stabilizer 2
DS-207 1
Plasticizer As shown

S.O.—Sweat Out

Plasticizer Performance in Vinyl Films

Performance Properties	Concentration of Flexol PEP, PHR				Flexol 10-10 at
	40	50	70	54[a]	50 PHR
Tensile Strength, psi	4020	3440	2820	3300	3230
Ultimate Elongation, %	216	240	310	250	275
Elongation at 1,000 psi, %	8	24	59	27	29
Durometer A Hardness	92	84	68	80	84
Stiffness at 23° C, psi	5700	1900	630	1400	1920
T_4 ° C[b]	22	16	—3	13	12
Brittle Temperature, ° C[c]	—4	—12	—24	—14	—24
Loss from 0.004-in. film:					
Volatile Loss (24 hr. at 70° C), %	0.6	0.8	1.0	0.9	1.3
Water Extraction (24 hr. at 70° C), %	0.5	0.8	1.0	0.9	0.4
Oil Extraction (50° C, K)	0.4	0.9	2.5	1.1	1.3
Lacquer Marring (24 hr. at 40° C), %[d]	20	48	84	57	42
Rub-Off (50° C, K)[e]	0.6	1.1	2.5	1.3	1.6
Spew (2 weeks at 60° C, 100% Rel Humidity)	None	None	None	None	None

*Formulation:

Bakelite vinyl resin VYNW	100 parts
"Dyphos" stabilizer	2 parts
DS-207	1 part
FLEXOL plasticizer	as shown

(a) Standard concentration: 80 Durometer A Hardness.
(b) T_4 is the temperature at which a vinyl compound has a torsional stiffness of 10,000 pounds per square inch.
(c) Method used: A.S.T.M. D-746-52T.
(d) Sheeting in contact with nitrocellulose lacquer under a weight of 1 psi.
Softening measured with a Walker-Steele Swinging Beam Hardness Tester.
(e) $K = \frac{\text{Loss (grams)/square meter}}{\sqrt{\text{Time (hr.)}}}$

Light Stability

	Florida Exposure Sun-Hours to failure[1]—PHR[2]				
	1.5	3.0	7.7	15.4	54.0
Flexol PEP	250	250	750	1,000	1,000
Epoxidized soybean oil	100	250	500	500	250
Alkyl epoxy stearate	100	250	750	750	750

(1) A sun-hour is the cumulative period of 60 min. during which radiant energy amounts to as much as 0.823 gram-calorie per sq. cm. per minute. Failure refers to any alteration of film surface appearance which would cause withdrawal from service.
(2) Epoxy compound—Flexol DOP = 54 PHR

Heat Stability

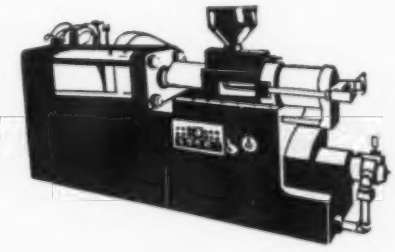
	170° C. Mill Stability Minutes to 75% BLR[1]—PHR[2]			
	1.5	3.0	7.7	15.4
Flexol PEP	14	20	24	20
Epoxidized soybean oil	16	15	18	20
Alkyl epoxy stearate	11	11	14	16

(1) blue light reflectance
(2) epoxy compound—Flexol DOP—54 PHR

Acknowledgment

The author wishes to thank members of the research, development, and technical service departments of Union Carbide Chemicals Co., especially W. J. Frissell, Group Leader, Plasticizers, who supplied the data for publication.

—The End



The Poly-Tite packager.

Blister packaging carried into the home

Movers throughout the United States are beginning to carry blister packagers into homes for enclosing breakable and easily lost items. By using the Poly-Tite packing process for china, glassware, condiments, etc., movers can decrease breakage, cost, loss, and messiness.

The Poly-Tite machine was developed by MfP Co., division of Avery Industries, Inc., San Mateo, Calif. The machine has its own dolly and chair assist, and thus can be moved into any home. Measuring 25 by 33 by 49 inches, it operates on 110 or 120 volt current. It will package items as large as 13 by 12 by 6 inches, weighing up to 35 pounds.

The machine can be operated by one man. A roll of six-mil polyethylene film supplied by Dobeckmun Co. is located under the forming section. The correct size film is inserted into the holder and sliced off. Polyethylene-coated corrugated kraft boards 18 by 18 by 30 inches are placed, with items to be packaged, underneath the sheet holder. The sheet is heated and the vacuum drawn and released within a period of 20-25 seconds. The finished items are packed in standard square barrels.

After the items have been moved to the new home, they may be stored as packaged indefinitely. —THE END

Abrasion and wear resistance of reinforced polyester surfaces

(Cont'd. from page 48)

the press, followed by a 3-hour postcure in the oven.

Vertical fibers were suggested as a means of improving abrasion resistance, but initial efforts at preparing laminates with vertical fibers perpendicular to the surface were unsuccessful. Suitable vertical fiber surfaces were prepared for the proof series using mohair as the reinforcing product. A low reactivity, styrene-thinned resin catalyzed with DDM gave us our test panels. Pressure was applied to the mohair in two of the panels to obtain horizontal rather than vertical fibers at the surface. The panels were gelled at room temperature and cured one hour at 170° F., and one hour at 250° F. in a circulating air oven to obtain a completely cured product (See Table 12).

The panels prepared for the "proof experiment" were evaluated only on the 1,000-turn CS-10 and CS-17 and the 500-turn NEMA tests, since the other tests used throughout the paper were felt to be inconclusive. The control laminate used throughout the initial phase was duplicated and given the required postcure. A reversal was found in the CS-10 and CS-17 abrasion values of the original and duplicate control panels, while the NEMA values were approximately equal. This would indicate that the postcure does not appear influential in abrasion resistance characteristics.

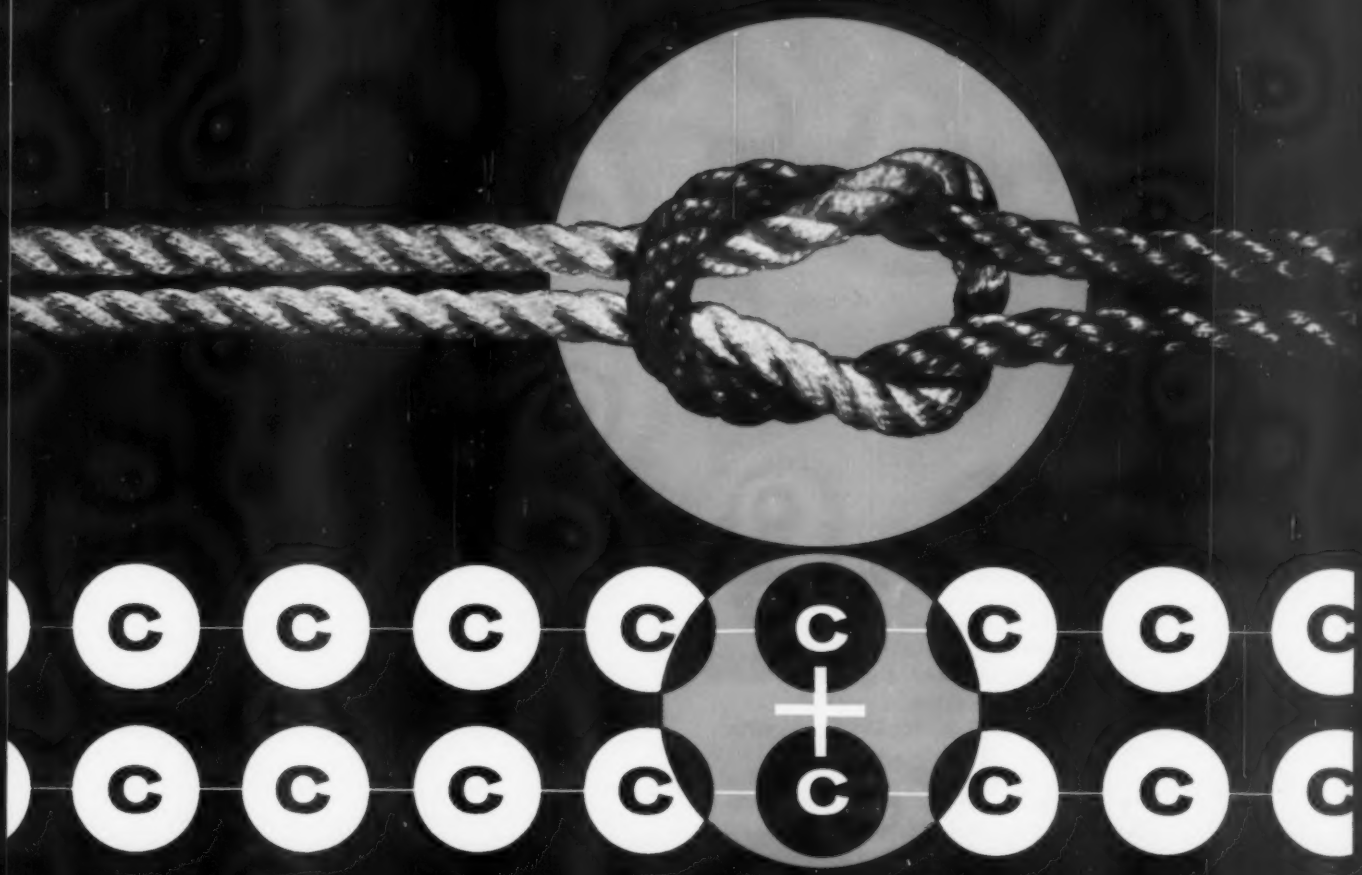
The high reactivity, isophthalic-acid diglycol resin was also somewhat disappointing, in that the only improvement was in the CS-10 test. These data seem to show that reactivity, isophthalic, and diglycol are also of little significance in their influence on abrasion resistance. The hgh-reactivity polyester, thinned with DAP, was also disappointingly poor in that the only improvement was shown in the CS-17 value. Diallyl itaconate, however, did show a general improvement in all three tests.

The epoxy molding was by far the most outstanding product tested in this series. It had approximately one-fifth the CS-10 and only one-fourth the CS-17 loss in weight when compared to the control molding. It should be noted that the NEMA improvement was smaller, but definite.

Only NEMA values were run on the vertical fiber series which showed very high abrasion in the control and the vertical fiber panels. Horizontal fibers appeared to give improvement, possibly because of the greater amount of organic fiber present in the wearing surface.

The final summary or conclusion from the data presented would be that melamine, epoxy, and allyl resin surfaces may be expected to give better abrasion and wear resistance than styrene-thinned polyester resins, and that school desk tops would appear to be more serviceable if prepared from one of these three materials.

—THE END



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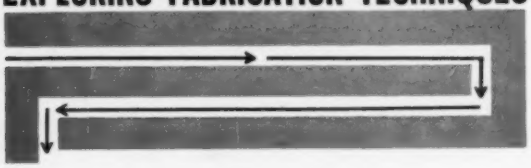

By L. J. ZUKOR, *ENGINEERING EDITOR*

Ultrasonic Sealing

A process that uses sound waves above audible range for welding plastic materials may sound highly theoretical. This very practical method, however, promises to do a better job on the new oriented film and sheet than the older methods of heat sealing and dielectric welding. A form of energy, ultrasonics occupies a place in the electromagnetic spectrum one step removed from the radio frequency (R.F.) band. R.F. bands include the frequencies of induction and dielectric heating as well as those of diathermy, radio, and T.V. In the welding spectrum, ultrasonics fall between the R.F. bands and the infra-red (conduction heating) bands.

I recently learned a good deal about ultrasonic welding while visiting at International Ultrasonics Inc., Cranford, N.J. Tom Scarpa, president of the company, showed me through his plant where I examined and operated a prototype of this company's proprietary machine. The results of several trials indicated that the ultrasonic method is adaptable to all thermoplastic materials and some thermosets. It is especially suitable for welding plastics which normally must be sealed at very high temperatures. Basically, the equipment consisted of a vibrating horn and an anvil. These two parts, acting in concert, cause joining to take place. Similar and dissimilar plastic materials can be welded together, or to other materials such as paper, cardboard, and textiles.

The process is a special extension of the general theory of adhesion concerning all materials. In essence, this theory states that any two materials will bond together if their surfaces are brought into close enough contact so that they are within atomic distances of each other. In ultrasonic welding, material surfaces are brought into sufficiently close proximity to each other by ultrasonic energy.

High-frequency electron field excitation is utilized in dielectric heat sealing; in contrast, ultrasonic sealing uses high-frequency mechanical impulses to effect a weld. Theoretically, heat is not a condition for inducing bonding. It is merely one of several (although most convenient) methods by which materials can be brought within atomic distances of each other. In many cases, the momentary melting of interface surface material of thermoplastics has no detrimental effect on the material's physical properties. Other plastics, such as the biaxially oriented polymers, will lose certain desirable properties when subjected to high bonding heats. Still others exhibit a tendency toward embrittlement at the boundaries of heat welded seams. In order to join these heat sensitive plastics, it becomes necessary to bring their surfaces within atomic distances of each other by some other means than making them molten.

Compared to both dielectric and conduction methods, the ultrasonic method offers a cold joining technique. The slight amount of frictional heat generated by the H.F. oscillations in the plastic is conducted away through the horn as rapidly as it is formed. This is evidenced by the fact that joints were obtained in the biaxially oriented polyester (Mylar), which exhibited strengths equal to 90-100% of the original material. The thermal rise induced as a frictional by-product was insufficient to cause molecular disorientation to any significant degree at the joint.

The apparatus used to accomplish the joining comprises an ultrasonic generator which drives an electromechanical transducer. The transducer assembly converts the electrical oscillations of the generator into powerful high-frequency mechanical vibrations. These vibrations are concentrated at relatively high ampli-

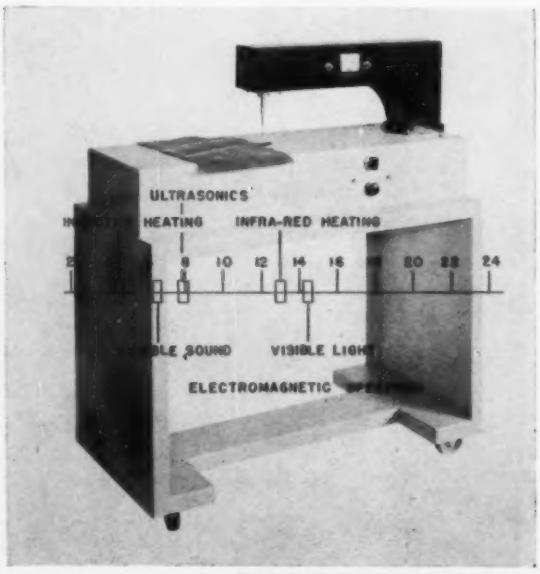

Photo courtesy: International Ultrasonics, Inc.

Ultrasonic sealing machine.
Chart calibrated in values of n for 10^n.

tudes into a small area by means of a special, mechanical, step-up "transformer" to which the transducer is affixed. This transformer or horn, as it is commonly called, is patterned after an invention of Dr. Warren P. Mason of Bell Telephone Laboratories.

The welding apparatus employs a specially designed welding tip which minimizes heat generation at the weldment. Only lap joints, either spot or seam, have been made by this method. A type of butt joint can be made by minimal overlapping of two sheet edges (5-30 mils). By precise mechanical control of the seaming operation, the joint can be thinned down in the process so that it is no thicker than the adjoining single sheet thickness, thus becoming a butt joint. Plastic films up to 20 mils thick have been seamed together with this apparatus. Seams may be made ¼-inch or wider on this machine.

Fabrics woven from plastic monofilaments can be spot- or stitch-welded to similar webbing, or to solid sheeting. Machine speeds of 50 ft./min. are possible, depending on the type and thickness of the material being welded. In addition, surfaces with intervening coatings such as metallized layers, photographic emulsions, powders, and even liquids (water and mineral oil) can be sealed without a previous cleaning operation. The intervening material does not become embedded in the seam, but is displaced by the H.F. vibrations and extruded out the sides of the seam.

The electronic circuit which produces the required ultrasonic energy is shown in the diagram. In the generator, vacuum tube V-1 serves as an oscillator producing 15-50 kilocycle beat signals. Tuning capacitor C sets the frequency of oscillation in conjunction with the fixed tank inductor L. The oscillating signal is fed to the power amplifier tube V-2 where the signal intensity is raised to a power level of 50-100 watts. A matching transformer T-1 couples this power to the transducer assembly, a standard lead zirconate titanate element, to which the horn and welding tip is affixed. A feedback signal taken from the welding array is carried through an automatic frequency control (A.F.C.) circuit and applied to the tuning condenser to keep the oscillator tube tuned to the exact frequency at which the welding array will resonate. This is necessary, since the welding head assembly represents a sharply tuned circuit. If the generator is not precisely tuned to the resonant frequency of the transducer, little power is transferred to it. Thus, inconsistent welding results are obtained. The feedback system and A.F.C. completely eliminate the need for continuous manual tuning (by causing the generator to track automatically the transducer frequency) as it varies under widely differing operating conditions.

—The End

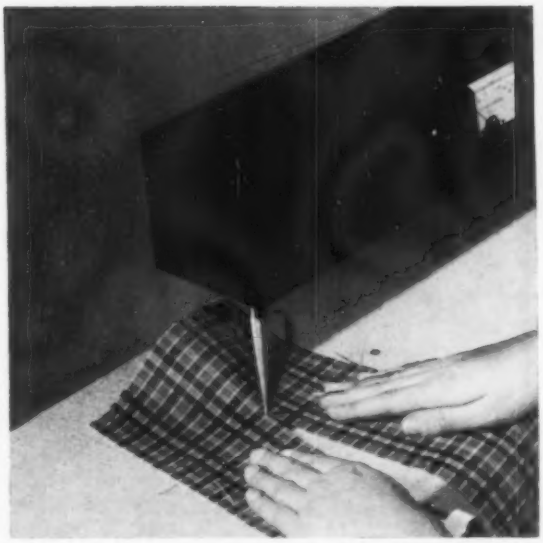

Photo courtesy: International Ultrasonics, Inc.

Ultrasonic sealing operation showing horn with welding tip attached.

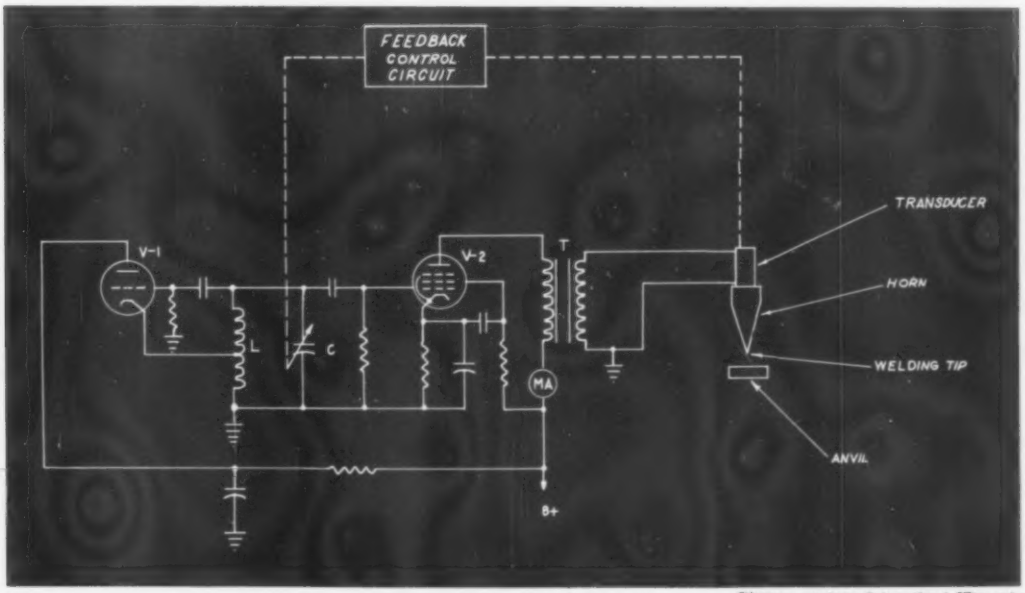

Diagram courtesy: International Ultrasonics, Inc.

Electronic generator diagram.

NEWS of the Industry

business developments

Midwest Technical Development Corp., Minneapolis investment firm, has invested $75,000 in Plastics Corp. of America, a recently organized Twin City firm. Plastics Corp. had acquired a 97% interest in Moxness Products, Racine, Wis., manufacturer of silicone and fluorocarbon insulation products.

Thatcher Glass Mfg. Co. has announced a $1,200,000 expansion program for its Muscatine, Ia., plant—the Celon closure and plastic tube divisions.

W. R. Grace & Co.'s polymer chemicals division is expanding the production facilities of its Baton Rouge high-density polyethylene plant by 50%. The Division has also added a complete range of polystyrene resins, plus low- and medium-density polyethylenes.

Air Reduction Co., Inc., has consolidated three chemical divisions—Air Reduction Chemical Co., Colton Chemical Co., and National Carbide Co.—into a new division known as Air Reduction Chemical & Carbide Co. President of the new division is G. R. Milne.

Toyad Corp. has announced the availability of production quantities of Chemfoam RSF, a self-extinguishing rigid urethane foam. Both two- and six-pound per cubic foot densities are offered.

Sterling Packing & Gasket Co. has opened a plastics division in Dallas where it will process Teflon and Kel-F resins.

Burlap Tubing Mfgrs., Inc., Philadelphia, has developed a method of laminating polyethylene to burlap. The burlap is available in many colors, and the product is known as Poly-Bel-Tex.

E. J. Brach & Sons Co., Chicago, has installed a Waldron-Hartig chill roll casting unit for polyethylene film to package its candy products.

General Box Co., Des Plaines, Ill., has formed a new division to produce polystyrene foam for packaging. The firm will both design and mold these plastic packaging materials at the Des Plaines plant.

Federal Tool Corp., Lincolnwood, Ill., has completed a merger with Proven Products, Inc., and Federal Premium Service, Inc., both of Skokie, Ill. The new organization is called Fedco Corp., and will operate the following divisions: Federal Housewares, Federal Tool & Die, Proven Products, and Federal Molding & Stamping.

Vulcanized Rubber & Plastics Co., Morrisville, Pa., has completed its reorganization program, and all executive and sales offices formerly located in New York City will operate directly from the plant.

Buhler Mill Engineering Co., Minneapolis, and Buhler Brothers, Inc., Englewood, N. J., have merged to form the Buhler Corp. Executive offices will be located in Minneapolis until the firm's new building in Golden Valley is completed—about May 1. New lines of die casting and injection molding equipment are scheduled for introduction.

Beckman Instruments, Inc., is using expanded polystyrene instead of pulp paper inserts in a protective package for glass electrodes.

Johns-Manville has assigned the major productive capacity of its Chillicothe, O., plant to the manufacture of Terraflex vinyl asbestos floor tile.

new plastics firms

Pittsburgh Corning Corp., a manufacturer of glass block and cellular glass insulation, has entered the polyurethane foam field. The firm is producing a wide variety of rigid foam slabs for thermal insulation to be known as Foamthane.

S. Leon Kaye has retired from manufacturing and set up a research and consultant firm at 158 Maple Ave., Metuchen, N. J. His former firm was Kaye Plastics Corp., located in Edison, N. J.

agents, distributors & agreements

Glaskyd, Inc., has been licensed by Rostone Corp., Lafayette, Ind., to manufacture a line of glass-reinforced alkyd molding compounds. Glaskyd is located in Perrysburg, O.

Atlas Machine & Tool Corp. has named Herbert V. Chanko, Flushing, N. Y., exclusive distributor for its Mark I and Mark X blow molding machines. Mr. Chanko no longer represents Kautex.

Glastic Corp., Cleveland, will suppy Spaulding Fibre Co., Tonawanda, N. Y., with fiber glass-reinforced polyester insulating material, and Spaulding will offer parts fabricated from Glastic sheet stock, channels, and angles.

Bean Fiber Glass, Inc., Jaffrey, N. H., has named Quentin Nelson & Co., as warehousing distributor for its woven roving in the Texas area.

Rainville Co. has been named distributor of the Doyle industrial vacuum cleaner.

Black-Clawson Co., has acquired the plastic extruder business of Aetna-Standard division, Blaw-Knox Co. Hale and Kullgren, Inc., will continue to serve as engineering and sales representatives for the line.

National Rubber Machinery Co. has appointed Barnett J. Danson & Associates, Ltd., its exclusive sales representatives in Canada. The firm is located at 1912 Avenue Rd., Toronto.

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We believe that these few pennies, invested in the right plasticizer, buy next year's vinyl business . . . the repeat business that stems from confidence in the consistent quality and performance of your product.

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The Second Stage Injector was designed to increase the effective operation of any Impco Injection Molding Machine now in service. It is also now available as standard equipment on new Impco machines. Its use gives you:

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HEINRICH-REIFENHAUSER EXTRUDER

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with handy gear shift

In addition to the floating screw control, the new 4½" Reifenhauser Extruder is available with a **high torque gear reducer and handy gear shift for instant change of the gear ratio.** Whether you need high screw speeds for a low viscosity material or low screw speed and high torque for a high viscosity material, simply use the handy gear shift and you are ready with a full 10:1 speed range for every extrusion application. **Screw sizes from 1¼" through 6"; Le/Dia. ratios 20:1 to 30:1. Packaged installations for film, sheet, monofilaments and biaxially oriented pipe.** Write for full information.

West or Wheelco controls, standard wiring with US fuses, standard heaters, bearings, rotary unions, pressure gauges.

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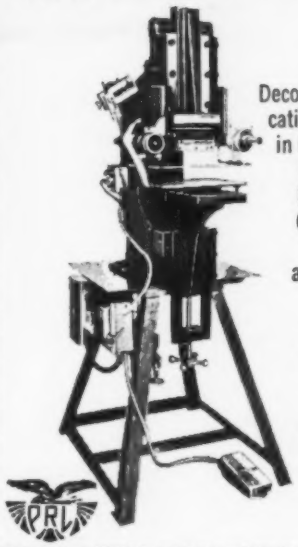

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New Materials

For more information check Readers' Service Card (p. 83)

Mold release agents

Chem-Trend has developed two mold release agents, one for release of flexible one-shot polyurethane foams, and the other for release of polyester and epoxy moldings. The former, designated Poro-Coat, is claimed to release foams with a completely open-celled surface, without skin formation. A fine dispersion of waxes and resins, it can be applied by spraying or brushing. It does not contain silicones.

Mono-Coat, for release of polyester and epoxy moldings, is suitable for both high-temperature and room-temperature cured systems. In most cases the part will be left with a mirror surface. Mono-Coat is a white, fluid dispersion which sprays or brushes easily.

Readers' Service Item 1

Epoxy resin materials

Ciba Products Corp. has announced the availability of four epoxy resin materials. Three—a curing agent for long pot life, a rapid curing agent, and a flexible resin—are available in development quantitites. The fourth, a solid, unmodified, resin, is now in commercial production.

Araldite DP-121 is reported to offer a longer pot life than other low viscosity curing agents used in solventless systems. The extended 2-3 day pot life of systems using DP-121 permits them to be applied with conventional spray equipment. Films of 5-10 mils can be applied in a single spray coat. Such finishes are claimed to cure to hard, tough flexible films possessing good chemical resistance. Araldite DP-121 has a viscosity of 10 cps. at 25° C., and a flash point of 270° F. Best results for coatings can be obtained by using it with liquid epoxy resins of low viscosity.

For a rapid, room temperature curing agent, Araldite DP-116 can be used. The following advantages are claimed: easy mixing ratio, non-inflammability, essentially no fuming on gelation, and lower exotherm during curing. It should be considered in laminating, adhesive, and other thin film applications. Depending on sample thickness, cure will be effected in 45 seconds to five minutes. Viscosity is 750 cps.; flash point 320° F.

Development quantities of a flexible epoxy, recommended as a modifier for conventional liquid epoxies to produce flexible systems, can also be supplied. Araldite DP-437 can be mixed in all proportions to provide a wide range of cured properties. According to Ciba, the resin is suitable for use in adhesives, caulking and sealing compounds, potting, coatings, and impregnating.

The fourth compound, available in commercial quantities, is designed to eliminate sintering and fusing during storage. Araldite 7072 can be used for adhesives, laminating, and surface coatings, and can be cured with most conventional agents. The compound melts at 75-85° C.

Readers' Service Item 2

ABS polymers

B. F. Goodrich Chemical Co. is manufacturing three acrylonitrile-butadiene-styrene compounds in the form of free-flowing, ivory colored powders. The compounds, which require no stabilization, are being sold under the name Abson. The materials are characterized by wide service temperature range and excellent impact resistance. Applications foreseen by the company include appliance parts where heat distortion is a problem; refrigerator linings; telephone handsets; boat and auto components; and toys.

Abson 89001 is made especially for extrusion; 89003 and 89006 can be extruded or injection molded; 89006 is recommended for general molding.

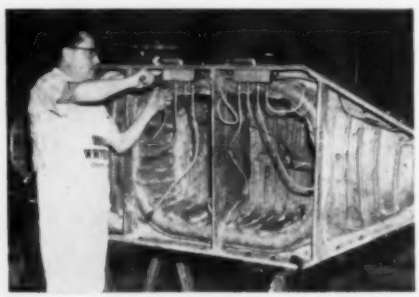
The company has also made available two resins for compounding and/or calendering. Abson 810X9 and 810X12 each have a specific gravity of 1.05. The molding compounds have specific gravities of 1.06. Other properties of compression molded specimens include:

	89001	89003	89006
Hardness, Rockwell R..	91	97	90
Durometer D.....	74	77	70
Tensile strength, psi....	4,300	5,300	3,800
Izod impact strength, ft. lbs./in. notch			
76° F.....	5–7	4–8	6–8
32° F.....	2.2	0.8	—
0° F.....	0.8	0.65	2.5
Flexural strength psi...	8,000	9,000	6,000
Flexural modulus, psi, (x 10^5).....	254	310	210
Compressive strength, psi.....	5,900	6,500	—
Heat distortion at 264 psi, °F.....	185	185	171
Elongation at break, %.	80	50	15

Readers' Service Item 3

Acetal copolymer

Celanese Polymer Corp. has announced the development of an engineering thermoplastic which promises to replace metals and other plastics in automobiles, appliances, industrial equipment, containers,



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when you need that EXTRA mechanical strength!

Not a very scholarly test, we'll admit, but we wanted to show what we mean when we say "You can beat Merlon for exercise but you can't beat it for toughness."

Exceptional impact resistance, high dimensional stability, transparency and self-extinguishing advantages are among the other reasons that make Merlon the new quality standard of the industrial thermoplastics.

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JUNE 5-9, 1961 — COLISEUM, N. Y. C.
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TENITE DEVELOPMENT LABORATORY DOINGS AND FINDINGS

WITH A LITTLE BIT OF LUCK

Remember the story of the Chinese boy who "discovered" roast pork the day his house caught fire and his pet pig failed to escape? A legend, probably — but logical. Chance has undoubtedly played a major role in many a discovery. Five or six years ago, for instance, some plastics engineers were watching experimental polyethylene paper-coating trials at a plant in upstate New York. Their eyes widened when the paper accidentally broke and the polyethylene coating continued to emerge from the chill-rolls . . . as highly lustrous film! Like the Chinese lad, the engineers got the implication. Today, chill-roll extrusion is a well-established technique for fabricating sparkling, highly transparent polyethylene film.

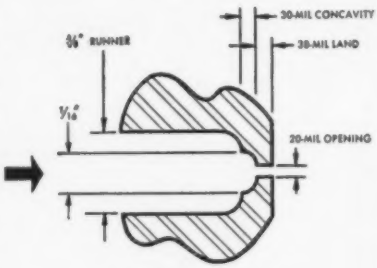
By investing in high-speed, chill-roll equipment for its own test purposes, Eastman has been able to develop excellent film-grade Tenite Polyethylene formulations for specific end uses such as bread overwrap.

SMALL GATE—BIG HELP

Every molder loves a small gate; it makes possible a part that comes quickly free of the mold and requires no trimming. Unfortunately, it may also impede flow, thus preventing the cavity from filling completely or slowing the molding cycle.

Through their test work with Tenite Acetate, Butyrate, and Propionate, Eastman's engineers have hit upon a new design for a 20- to 30-mil gate that often works where the conventional pinhole gate fails. Even where the pinhole gate has been found satisfactory, indications are that the new design can speed the molding cycle.

Here is the new design:



MODIFIED PINHOLE GATE

It differs from the conventional pinhole gate in just one small, but very important, way. The runner (or sprue, if runners are not used) stops just short of the gate's land. A machined cavity half the size of the runner then extends it to the land.

What makes the design work so well, we think, is the flow pattern that develops as the hot plastic enters the gate. The wavefront traveling down the runner breaks across the small concavity and forms streamlines that help the plastic shoot smoothly through the gate and into the mold.

A COOL 6 BILLION

Six billion pounds of frozen food, we're talking about. That's the astronomical figure projected for 1970. Naturally, the packaging for such a harvest takes on prime importance. Eastman's popular entry in this pouch-packaging field: Tenite Polyethylene 161M Natural. This new polyethylene formulation, with a density of 0.923 and a melt index of 0.7, has been exceptionally well-received for making film used to package foods that are IQF—individually quick frozen. The significant word is individually. With each little pea, bean, or carrot cube frozen separately from its fellows, vegetables remain loose rather than becoming a solid block, and can be poured from the package in just the quantity needed for immediate use.

A preliminary survey (we asked our wives) reveals that the housewife not only prefers IQF foods because of their loose form, but also finds the polyethylene pouch much easier to open than boxes.

For more information on Tenite Polyethylene 161M, contact your nearest Tenite representative or write to Eastman Chemical Products, Inc., Plastics Division, Kingsport, Tennessee.

TENITE®
plastics by Eastman

pipe, and other products or components. Celcon acetal resin is noted for high heat resistance and long term creep resistance. Further, there is little sign of molded-in stress, even in moldings with complex contours. The material will not begin to sag until the temperature comes within five degrees of the melting point.

The material will not be commercially available for another year, but extensive testing indicates that it can be economically injection molded in both simple and intricate designs, as well as extruded and blow molded into containers and other items.

Celanese expects that the largest immediate use of Celcon will be in replacing such metals as die-cast zinc and aluminum, and brass, copper, and steel. Some Celcon properties, which reflect short-term characteristics of ⅛-inch injection molded specimens, are tabulated below:

Specific gravity	1.410
Hardness, Rockwell M	76
Izod impact strength, ft. lbs./in. notch	
73° F., 50% R. H.	1.1
−40° F.	1.0
Unnotched	
73° F., 50% R. H.	20
−40° F.	15
Tensile strength, psi., 73° F., 50% R. H., 0.2 in./min.	
Yield strength	8,800
Break strength	8,000
Elongation, %, 0.2 in./min.	12
At yield	12
At break	40
Modulus of elasticity in tension, psi	375,000
Flexural strength, 5%, psi	12,000
Deflection temperature, °C., 264 psi	110
°F.	230
Vicat softening point, °C.	160
°F.	320
Deformation under load, %, 2,000 psi., 122° F.	1.0
Linear coefficient of expansion, in./in. °F.	4.5 x 10^{-5}
Mold shrinkage, range, in./in.	0.02–0.03
Water absorption, 24 hr. immersion, %	0.25
Coefficient of dynamic friction	
Steel	0.15
Brass	0.18
Aluminum	0.20
Tabor abrasion, mg./1,000 cycles	
1,000 gram load, CS-17 wheel	14
100 gram load, CS-17F wheel	6

Readers' Service Item 4

Also worth mentioning

☐ Sackner Products, Inc. is producing a woven glass fiber roving made of random spun glass fibers. The material is claimed to have outstanding draping, stretching, cutting, forming, and wetting characteristics. It is available in various thicknesses.

Readers' Service Item 5

☐ A raw methyl methacrylate monomer for production of cast acrylic sheets in the sign and lighting industries has been introduced by E. I. du Pont de Nemours & Co. Designated Monocite H 100, the monomer can be cast into sheet which is impervious to weather and will not yellow.

Readers' Service Item 6

Glidden

introduces
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CADMOLITH® REDS

Here are five new Cadmolith red colors to give you brighter, cleaner formulations and products. Elimination of brown undertones has actually made these reds redder.

This new line of brilliant colors retains the important traditional Cadmolith features of permanence, heat, acid and alkali resistance.

New Glidden improved Cadmolith reds as well as standard Cadmolith reds are available in both regular and dispersion grades.

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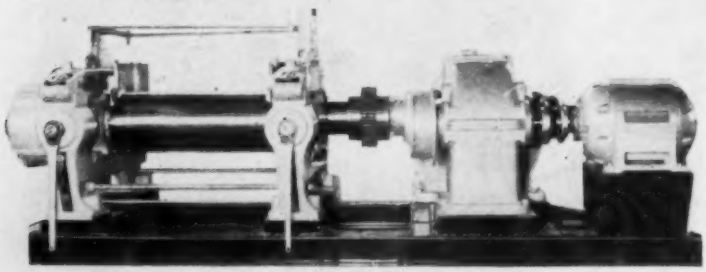

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Singled out from the broad range of Bolling equipment for the rubber and plastics industries, this unit, the 60" mill has become an outstanding leader in the field. Into it Bolling's 30 years' close-hand knowledge of milling conditions and requirements has built optimum reliability and economy. Original cost—reasonable. Maintenance—minimum. Production—pleasingly high. Construction—rugged in the extreme. Installation—easy, since several types of drive are available. The 60" mill illustrated has Stewart Bolling's own direct-connected drive, mounted on one-piece base.

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LOW COST

Vacuum Forming

in your own plant

Now, for a minimum investment you can control your own production – produce blister packages, displays, 3-D letters, toys and many other vacuum-formed products. The Model 300A, illustrated, utilizes a wide range of thermoplastic materials – vinyls, styrene, polyethylene, butyrate, acetate, in sheets or rolls. No special training is required and changeover from one mold to another takes only minutes. You enjoy the flexibility that comes only with control of your own supply.

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Although molds may be easily made in your own shop, our extensive mold-making facilities and expert craftsmen are at your service.

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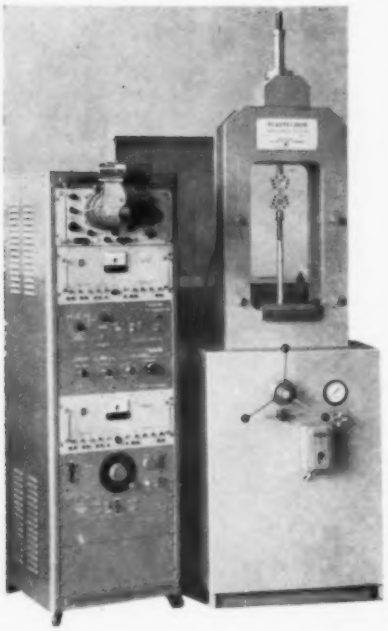
New Equipment

For more information check Readers' Service Card (p. 83)



Universal tester

The Plastechon universal tester will measure tensile, flexural, and compressive properties of all types of materials at rates of loading from 0.2-8,000 inches per minute. The floor model testers, manufactured by Plas-Tech Equipment Corp., measure load by means of a strain gage type cell, and elongation by a potentiometric transducer attached to the bottom of the piston. Linearity of piston travel is controlled by an error signal which is amplified and fed into a servo control system. Stress-strain curves are plotted on an oscilloscope screen and photographed.

The Plastechon is designed for remote control operation. The electronic console can even be operated in another room. In operation, the piston is actuated by the camera shutter.

The test frame consists of two ground steel plates fastened by four machined columns. A load-cell support block with shouldered removable spherical seat allows for self-alignment of the test specimen. The operating ram-cylinder assembly is mounted in the bottom portion of the frame, with a spherically seated grip adaptor attached to the ram for axiality of loading.

General specifications of two models follow.

	Model 591A	Model 591B
Capacity in tension, lbs.	2,500	10,000
Speed of piston, in./min.	½–8,000	¼–6,000
Piston travel, in.	10	4
Distance between heads, in.	24	24

Readers' Service Item 21

Twin-drive granulators

Injection Molder Supply Co. is manufacturing two twin drive granulators. Model XD-1 is a 3 hp. granulator with a throat measuring 5⅜ by 8½ inches. Model XD-2 is a heavy duty, 7½ hp. granulator with a throat measuring 12 by 12 inches.

Both models feature double flywheels for extra impact. Double V belt drive minimizes rotor twist and belt slippage on the acetals, polycarbonates, and other tough plastics for which the grinder was designed. Standard models come with two-bladed rotors, but three-bladed rotors can be ordered.

Dimensions of XD-1 are 26½ by 22½ by 52 inches high; of XD-2, 28 by 32 by 60 inches high. Standard equipment includes material catch pan, front and top opening hopper lid, starter with overload protection, adjustable motor base, and heavy duty casters.

Readers' Service Item 22

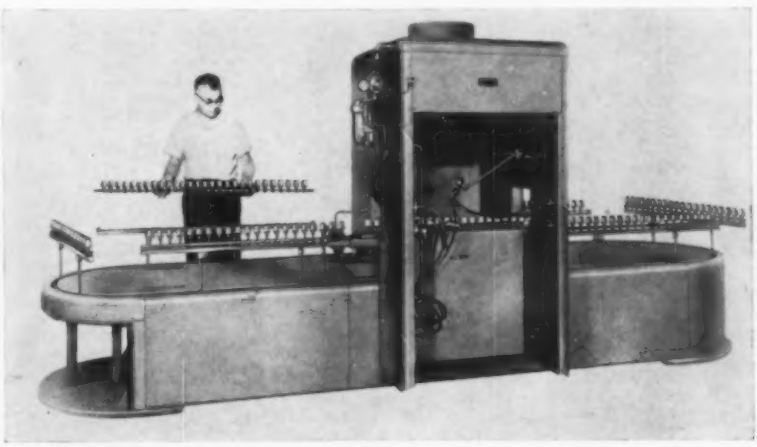
Spindle spray-painting machine

According to Finish Engineering Co., Inc., the Rid-the-Rod painting machine offers a large saving in labor and reduction of rejects. Primarily designed for use in multiple coat painting operations, the equipment may also be used as a conventional chain on edge painting machines.

Components are placed on spindles which are attached to carrier rods independent of the moving chain. Each rod carries 20-30 parts through all stages of prime coating, finish coating, baking, and metallizing. Downtime is reduced during changes from one job to another; rods can be loaded in advance and placed on the chain immediately after the changeover.

The machine can be used with rotating or non-rotating work holders. For long runs the parts can be loaded automatically and coated at speeds up to 30,000 per hour. Speed of machine is 200-600 rods per hour, adjustable. Speed of part rotation is adjustable independently of carrier rod speed.

Standard equipment includes two spray guns, a five-gallon pressure tank, and exhaust fan with explosion-proof motor. Drive for the two-inch pitch chain is adjustable on a 1:3 ratio. While it is built to suit customers' requirements, the usual dimension of the machine is 16 feet long by 5 feet wide.



Readers' Service Item 23

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FOR POLYESTER RESINS AT INTERMEDIATE AND LOW TEMPERATURES

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Write for Data Sheet or Consult CHEMICAL MATERIALS CATALOG Page 179

LUCIDOL DIVISION

WALLACE & TIERNAN INC.
1740 MILITARY ROAD
BUFFALO 5, NEW YORK

Container printing machine

Equipment for printing flat and oval plastic bottles in three colors at one pass of the press has been made available by International Eastern Co. Model R1MF/3F is a flatbed, offset printer which will handle up to 1,000 containers per hour.

Containers are spanned, pushed in, or inserted into a working plate. A rubber cylinder, fed by six rollers (two for each color), prints as the working plate is lowered. Idler guides control the inking rollers. The entire automatic process is driven by two three-phase motors, one of which controls only the inking system.

Printing surface is approximately 6½ inches square. Feeding width is 12½ inches. The machine measures 60 by 28 by 39 inches.

Readers' Service Item 24

Canadian Injection Molder

Husky Manufacturing and Tool Works Ltd. has begun to distribute its injection molding machines in the U. S. and Canada. A general purpose machine, it is recommended for thermoplastic container production. Thin walled containers can be molded at rates up to 30 per minute. Piston hold time is minimum.

Standard specifications of HM 15/19 are:

Platen size, inches	15 x 19
Clamping pressure, tons	75
Plasticizing capacity, lbs./hr.	44
Dry cycles/minute	7.5–30
Maximum piston stroke, inches	4½
Cylinder plunger diameter, inches	1¾

Optional are variable speed drives for injection and clamping units; low pressure closing; clamping strokes from 5-10 inches; injection strokes from 2½-4½ inches; weigh feeder; and others.

The U.S. distributor is Husky of America, Inc.

Readers' Service Item 25

☐ Standard Steel Corp. has designed and manufactured a pilot dryer for drying plastic resins with superheated solvent vapor. Solvent vapor from the plastic is recycled through the dryer for use as a heat vehicle. The dryer is 12 inches in diameter and eight feet long.

Readers' Service Item 26

☐ Grieve-Hendry Co., Inc., has developed a line of recirculating electric and gas-fired package air heaters. Temperatures range from 450-1250° F.

Readers' Service Item 27

☐ Motion Control Machines Model M-100 is designed for high production drilling of printed circuit panel boards. Using solid carbide drills, accuracy is maintained to ±0.005 inch. Up to 10,000 holes per hour can be drilled in epoxy glass by drilling six 1/16-inch boards at one time.

Readers' Service Item 28

Plastics Applications

For more information check Readers' Service Card (p. 83)

Sled on skis

The Snow Ski Sled is designed for safe recreation in the snow. Produced by Ski Sleds, Inc., of San Francisco, Calif., the sled consists of a plastic seat attached to three broad ski runners. The three runners provide excellent stability.

The seat, footrests, and runner tips are molded of yellow Cycolac rigid ABS resin manufactured by Marbon Chemical Division of Borg-Warner Corp. The material was selected because of its superior impact strength over a wide temperature range. Because of potential use in extremely cold weather, the material had to be rigid at sub-zero temperatures. There was no sign of corrosion from contact with ice and snow.

Because of its light weight, the sled can be loaded atop a car.

Readers' Service Item 41

Epoxy trailer truck

The era of pink, pale blue, and peach trailer trucks is approaching. The Trailer of Tomorrow, a plastic-skinned experimental model developed jointly by Highway Trailer Industries, Inc., and Union Carbide Plastics Co., will serve a decorative as well as functional purpose on America's highways.

The one-piece Hipoxcel top and side panels are made of fiberglass-reinforced epoxy resin, which can be molded in any color. The translucent top illuminates the van interior without requiring installation of skylights. Since the plastic panels can be bonded to the structural members, the number of rivets and mechanical fasteners formerly required has been reduced.

The panels have half the weight of, equal tensile strength to, and greater compression strength than the aluminum they replace.

Readers' Service Item 42

Cast hermetic-seal bushings

Model M-1003 hermetic-seal feedthrough bushings, cast of epoxy, are designed for soldering into hermetically-sealed metal equipment enclosures. They can be mounted in any position, according to Components for Research, Inc.

Construction features internal stress-control structure for uniform field distribution over the epoxy surface. The bushing is rated for corona-free operation at 40 kv. Peak pulse operating level is greater than 70 kv. for air-to-oil, and 140 kv. oil-to-oil.

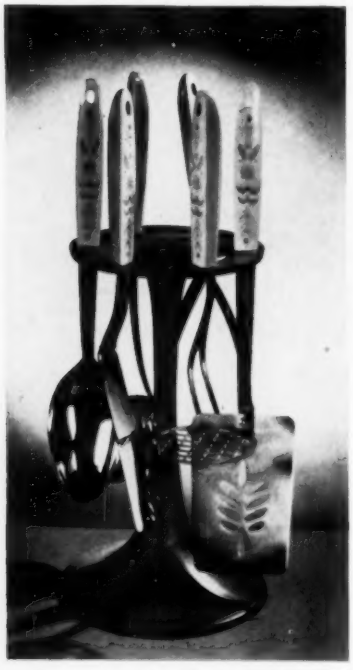
Readers' Service Item 43

Pyro-Bol Corp. is manufacturing a pipe with nylon stem, cooling fins, and top ring; and glass smoking bowl. The nylon is supplied by M. R. Plastic Research Corp., and the Kimax glass bowl by Kimble Glass Co.

Readers' Service Item 44

White door and window handles on the Ford Motor Co.'s Econoline truck are molded of Du Pont's Delrin acetal resin. The black knob on the window regulator, molded with four-pronged shafts for a simple snap fit assembly, is of Zytel nylon resin.

Readers' Service Item 45



Decorative kitchen tools

Ekco Products Co. is marketing Flint Cook and Serve Tools with melamine handles. The attractive, sturdy handles have an early American floral design molded on a beige and white background. They are molded from American Cyanamid Co.'s Cymel 1077 melamine molding compound.

According to Ekco, the decorative pattern lasted through extensive abrasion testing and repeated, intentionally rough washings in an automatic dishwasher.

The tools can be purchased in a specially designed mobile holder. The rotating Counter Susan can be used on a counter top, in a cabinet, or on the dining room table.

Readers' Service Item 46

A fiberglass-reinforced polyester luggage carrier for mounting on car roofs is being distributed by Fabricon Products. Called the Auto-Attic, the carrier can be adjusted to fit almost all cars, including compacts.

A cylinder lock prevents theft of the rack or its contents. For carrying long materials such as lumber, the hood may be detached.

Plaskon material is used.

Readers' Service Item 47

Miniature electronic component

Machined on a production line basis with automatic lathe equipment is this minute coil form for a solenoid safety switch on a warning light circuit for jet aircraft. The part, measuring 0.725 inch in length with 0.325-inch diameter flanges of 0.100 thickness at either end, is machined in one piece from ½-inch extruded Merlon polycarbonate rod.

The part replaces a metal form of the same dimensions. Use of polycarbonate eliminates the need for coating for electrical insulation and corrosion resistance.

The component is produced by Grimes Mfg. Co. using Merlon polycarbonate resin produced by Mobay Products Co.

Readers' Service Item 48

VINYLS • POLYOLEFINS • ACRYLATES • EPOXIES
POLYESTERS • URETHANE FOAM • POLYSTYRENE

In recent years, antimony oxide has found greatly increased use as a flame retardant in a wide range of flammable materials—particularly plastics. Polyolefins, polystyrene, vinyls, polyesters, acrylates, epoxies and urethane foams are among the plastics in which antimony oxide has been used to provide the necessary degree of safety for consumer products.

A bibliography, "Reported Uses of Antimony Trioxide as Fire and Flame Retardant," has been compiled by M&T and is available on request. Offered by M&T are grades of antimony compounds specially made for these applications. Particularly interesting is their range of opacity, permitting optimum formulation when color and appearance is a consideration. Send for technical literature on THERMOGUARD*H, THERMOGUARD*L, and M&T Flame Retarder. These three antimony-based compounds offer a wide range of tinctorial strengths. *Trademark

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METAL & THERMIT Corporation, Rahway, N. J. Dept. T

In Canada: M&T Products of Canada Ltd., Rexdale, Ontario

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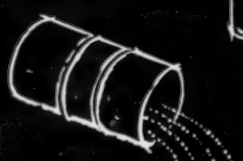

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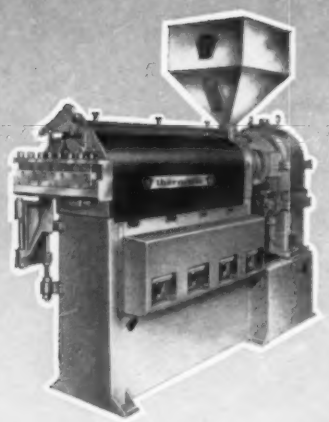

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6 WATER STREET, MYSTIC, CONNECTICUT

Polyethylene blinker head.

Blinker light head

A barricade blinker light available from Walter Roberts Enterprises, Inc., has a head blow molded of linear polyethylene. Its advantages over the metal head it replaces are resistance to corrosion and chipping, and ease of replacement at low cost. It is already in use in many road construction projects and barricades.

The material, Union Carbide Plastic Co.'s 4901 NT, is unaffected by corrosive action from defective or worn out batteries. The semi-translucent polyethylene, colored yellow by dry coloring, allows light to diffuse through the entire head.

Blow molded by De Witt Plastics, the head is 24 inches high and 9¼ inches wide.

Readers' Service Item 49

Also Worth Mentioning

☐ Cellusuede Products, Inc., has developed a rayon flocking for Du Pont's Mylar polyester film. Claimed to be soft and velvet-like in appearance, the flocked film can be used as a sound and vibration absorber. The Mylar is used in thicknesses of 1½ mils, to which 0.030 inch of rayon flocking is added.

Readers' Service Item 50

☐ Heavy duty, fluorescent valve stem caps for truck tires are being marketed by Howard Enterprises, Inc. Glo-Cap tire savers are molded of Plaskon nylon 8202 supplied by Allied Chemical's plastics division. The caps are intended to prevent valve stem swallowing, thereby cutting down on damage caused by run flats.

Readers' Service Item 51

New Literature

For more information check Readers' Service Card (p. 83)

"Type RG Rotoblast." Bulletin No. 227A Pangborn Corp. 8 pages. The Rotoblast impeller uses controlled centrifugal force for blast cleaning power. Diagrams and cut-away drawings illustrate design, which is explained in the text.

Readers' Service Item 61

"Fiber Glass Textile Yarn." Brochure No. FTX-5A. Textile Glass Department, Fiber Glass Division, Johns-Manville. 12 pages. Explains fiberglass manufacture and nomenclature. Tables compare properties of different fibers and present data on continuous filament glass yarn.

Readers' Service Item 62

"Morflex Specialty Plasticizers." Data Sheet No. 556. Charles Pfizer & Co., Inc. 17 pages. Specifications, physical properties, and typical performance data in vinyl films are tabulated for 12 plasticizers.

Readers' Service Item 63

"Textolite Copper-Clad Laminates for Printed Circuits." L-CDL-458. Laminated Products Department. General Electric Co. 8 pages. Data on three epoxy glass laminates, three phenolic paper laminates and two epoxy paper laminates. Brief descriptions of features. Sizes and tolerances.

Readers' Service Item 64

"Versatile Plastics Welders for Sealing and Welding of Thermoplastics." Bulletin 60-1. Kamlar Products Co. 2 pages. Describes and illustrates hand welder and tacker, medium- and high-speed production welders, all purpose welder, job welder, and special tips and tools. Can be used with polyethylene, polypropylene rigid and plasticized PVC, and plasticized tank linings.

Readers' Service Item 65

"Preparation of Polyethylene Surfaces for Bonding." TSB-3-625-1060. Mereco Products Division, Metachem Resins Corp 2 pages. Soaking polyethylene in an acid bath enables it to be bonded with epoxy adhesive. The method is recommended in encapsulation of electronic components and in applications where bondable Teflon is utilized.

Readers' Service Item 66

"Molding Resin Product Data Guide." "Film Resin Product Data Guide." "Product Data Guide." Rexall Chemical Co. 16 pages. Technical data and general information on Elrex polyethylene resins. Densities range from 0.910 to 0.965.

Readers' Service Item 67

"High-Pressure Acetylene Derivatives." #AP-60-3. Acetylene Chemicals Department, Antara Chemicals. 6 pages. Materials described are PVP, PVP/VA copolymers, PVP-iodine, vinylpyrrolidone, methylpyrrolidone, 2-pyrrolidone, butyrolactone, 1,4-butanediol, butenediol, butynediol, and propargyl alcohol and halides.

Readers' Service Item 68

"Rona Pearl Pigments." Rona Pearl Corp. 12 pages. Properties, typical uses, and general procedure concerning applications of natural and synthetic pearl pigments are outlined. Separate sections cover technical information on coating, casting, compounding, and cosmetics.

Readers' Service Item 69

"Magic-Vulc Industrial Adhesives." Magic Chemical Co. 2 pages. Types of adhesives; industrial applications. Services of the company are outlined.

Readers' Service Item 70

"A More Effective Stabilizer Against Light and Oxygen for Polyethylene, Polypropylene, and Polyvinyl Plastics." Guardian Chemical Corp. 7 pages. Effect of light and heat on thermoplastics is described. Directions for and advantages in using Voidox 100% as a stabilizer are presented.

Readers' Service Item 71

"Plastic and Chemical Materials." CDC-381. Chemical Materials Department, General Electric Co. 12 pages. This illustrated catalog covers product features, applications, and technical data on Lexan polycarbonate resins and phenolic molding powders. Also described are phenolic laminating varnishes, foundry resins, and industrial resins and varnishes.

Readers' Service Item 72

"Ultraviolet-Resistant Tenite Polyethylene." MB-5. Eastman Chemical Products, Inc. 2 pages. Results of tests comparing properties of stabilized exposed and unexposed film are tabulated. The stabilized film retained a high degree of clarity and remained smooth, pliable, and tough when exposed to weathering.

Readers' Service Item 73

"Our BIPEL Preform Rate jumped from 1900 to 3300 per hour!"
So reports General Industries Co., Elyria, Ohio . . . on their new BIPEL Horizontal Hydraulic Preformers. Leading producers everywhere are praising these faster, more flexible units. Are you getting maximum results? Write for complete information.
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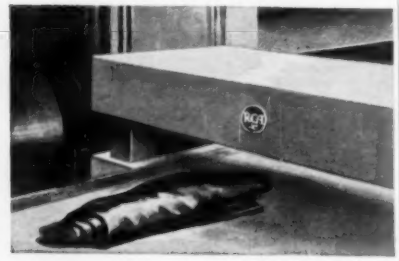

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Book Reviews

"Properties of Matter." F. C. Champion and N. Cavy. Third Edition. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. Cloth, 6 by 8¾ inches, 334 pages. $10.00.

This advanced physics text and laboratory reference deals with the absolute theory of the kinematics of solids, liquids, and gases. In contrast to the largely phenomenological treatment of the subject in the two earlier editions, the revised orientation to the topics calls for atomic interpretations. For example, the unit of time may now be defined primarily from an atomic clock; and the diffusion in solids can be interpreted in terms of vacant atomic sites and interstitial atoms.

Treatment of optics and interference spectra is not included. Chapters cover units and dimensions, acceleration due to gravity, the Newtonian constant of gravitation, elasticity, compressibility of solids and liquids, seismic waves, capillarity, surface films, kinetic theory of matter, osmotic pressure, diffusion, viscosity, errors of measurement, and methods of determining Planck's constant.

The book should be of interest to designers of such instruments and highly specialized machines as vacuum metalizing chambers and viscosimeters. Those concerned with physical testing of polymers will also find it helpful.

"The Chemical Industry Facts Book." Fourth Edition. Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave., N. W., Washington 9, D. C. Paper, 6 by 9 inches, 163 pages. $1.25.

This volume is divided into four main sections: I—the history, characteristics, position, and future of the chemical industry in the United States; II—operation of the industry, including raw materials, labor, plants, finances, and research and development; III—everyday uses of chemicals in food, agriculture, shelter, etc.; and IV—role of chemicals in defense, nuclear energy, and space applications.

An introduction consists of summaries of the highlights of each chapter. Appendices covers discussion of the MCA, bibliographies, and a glossary.

The book is primarily a statistical survey of the industry. The text interprets the figures on a level which can be understood by the layman. Emphasis is on raw and intermediate materials. For example, there is little discussion of plastic resins as such, but intermediates are included.

"Amino Resins." John F. Blais. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 7¾ by 5¼ inches, 220 pages. $4.95.

This review is largely confined to those amino resins which are commercially important, namely, urea and melamine resins and their modifications. Chemistry, manufacture, and application of these two thermosetting materials comprise the bulk of this volume. There is also brief discussion of the benzoguanamine resins used for laminating and surface coating.

The original ureas were similar to the phenolics, except that the ureas could be pigmented light colors. This important characteristic has enabled both ureas and melamines to find wide outlets in consumer products for which the cheaper, but dark-colored, phenolics were not suitable. By now the aminos have developed individual characteristics, but their eye appeal is often the reason for their use instead of phenolics, which are about one-third cheaper.

The properties of molded urea products depend on the raw material and filler. They generally have smooth, wear-resistant, lustrous surfaces, and will not support combustion. Unpigmented urea filled with very pure alpha cellulose can be used for translucent lighting applications. The most familiar molded melamines are dishes and other serving pieces. The alpha cellulose filled melamine used for tableware is attractive as well as resistant to scratches, impact, and repeated cleaning. Both urea and melamine moldings have high specific gravities in comparison with thermoplastics, and thus are economically disadvantageous where cost per unit molded volume is important.

Other outlets for amino resins include the preparation of adhesives, laminates, papers, and surface coatings. While urea adhesives are the most economical, melamine-urea or straight melamine adhesives provide the greatest moisture resistance and durability. Specific techniques for use with different products are outlined. In laminating applications, melamines are the most prominent. Their use in decorative laminates exceeds that of use in industrial and electrical grades. Aminos are used in paper manufacture to develop wet strength and stabilization and to improve coatings. The surface coatings industry uses them to prepare baking finishes for such surfaces as metal, wood, or composition board.

Mr. Blais has contribued a readable guide to the application of amino resins and the specific type of resin most suitable for each application. He is less concerned with the possible future applications than with those which have already been developed.

Patent Digest

Materials

Glass-Reinforced Thermoplastic Resin Compositions Based on Synthetic Linear Polypyromellitimides. No. 2,944,993. D. L. Brebner, Claymont, and W. M. Edwards, I. M. Robinson, E. N. Squire, and H. W. Starkweather, Jr., Wilmington, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Blend of Chlorotrifluoroethylene Homopolymer and Chlorotrifluoroethylene Vinylidene Fluoride Copolymer. No. 2,944,997. S. Gates, S. Charleston, and D. H. Mullins, St. Albans, W. Va. (to Union Carbide Corp.).

Stabilized Cured Polyurethanes. No. 2,944,998. E. C. Buxbaum, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Resinous Compositions Light Stabilized with a 2,4-Diamino-6-(p-Alkoxy-Styryl-s-Triazine. No. 2,944,999. F. J. Abbruscato, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

Linear Polyester Compositions Containing an Alkyl Gallate as a Heat Stabilizer. No. 2,945,000. S. H. Long, J. W. Tamblyn, and L. D. Moore, Jr., Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

Water-Soluble Interpolymers of Acrylic Acids and 2-Ethylhexyl Ester of Acrylic Acids and Method of Making Same. No. 2,945,013. J. B. Ott, Northampton, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

Linear Condensation Polymers from p-Carboxycarbanilic Acid. No. 2,945,007. J. R. Caldwell and R. Gilkey, Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

Condensation Polymers Derived from Spiroglycols. No. 2,945,008. J. R. Caldwell, R. Gilkey, and B. S. Meeks, Jr., Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

Synthetic Resinous Composition Containing a Modified Polyamide and the Condensation Products of a Polyhydric Phenol and an Halohydrin. No. 2,952,647. **Production of Resinous Polyamides by the Reaction of a Monomeric Polyamine with the Product of a Styrene and a Dehydrated Castor Oil Fatty Acid.** No. 2,952,648. G. Swann, Hunts Cross, Woolton, and P. G. Evans, Liverpool, England (to Beck, Koller & Co. (England) Ltd., Liverpool, England).

Polymerizable Polyester and Polymers Thereof. No. 2,945,012. A. R. Berens, Hudson, O. (to B. F. Goodrich Co., New York, N. Y.).

2-Trifluoromethyl-Butadiene Copolymers and Preparation Thereof. No. 2,951,065. E. S. Lo, Elizabeth, N. J., and G. H. Crawford, Jr., Staten Island, N. Y. (to Minnesota Mining & Mfg. Co., St. Paul, Minn.).

Latent-Foaming Vinyl Aromatic Polymer Compositions and Method of Making the Same. No. 2,952,594. L. C. Rubens, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

Composition Comprising a Vinylidene Cyanide Copolymer and a Cyanoethyl Compound as Plasticizer. No. 2,952,653. H. Heller, Akron, O. (to B. F. Goodrich Co., New York, N. Y.).

Vinyl Chloride Polymer Plasticized with N,N,N',N' Tetraalklyphthalamide and Process of Making. No. 2,952,654. C. E. Adams, Highland, and J. P. O'Brien, Whiting, Ind. (to Standard Oil Co., Chicago, Ill.).

Linear Polyethylene Stabilized with Alkali Phosphates. No. 2,952,658. C. R. Pfeifer and M. R. Kinter, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

Composition Comprising a Rubbery Reaction Product of an Organic Polyisocyanate and a Dihydroxy Terminated Polyester. No. 2,953,539. O. C. Keplinger, Cuyahoga Falls, and O. C. Elmer and J. S. Duncan, Akron, O. (to General Tire & Rubber Co., Akron, O.).

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Prices, 25c each
—The Editor

Thermal Stabilization of Haloethylene Polymers. No. 2,952,660. C. B. Havens, Midland, Mich (to Dow Chemical Co., Midland, Mich.).

Linear Polyethylene Stabilized with Alkali Metal Salts. No. 2,952,659. C. R. Pfeifer, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

Polyamides of 4-Carboxypiperidine. No. 2,952,667. J. R. Caldwell, Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

Equipment

Apparatus for Processing Elastomeric Material. No. 2,944,285. T. J. Rhodes, Smoke Rise, Kinnelon Borough, N. J. (to U. S. Rubber Co., New York, N. Y.).

Extrusion Screw Adjusting Mechanism. No. 2,944,286. G. V. Kullgren and D. W. Stephenson, Akron, O. (to Blaw-Knox Co., Pittsburgh, Pa.).

Apparatus for and Method of Extruding Plastic Materials. No. 2,944,287. J. N. Moran, Waco, Tex. (to Phillips Petroleum Co.).

Combination Plasticizer, Extruder, and Injection Cylinder with Recirculation. No. 2,944,288. O. B. Sherman, Toledo, O. (to Owen-Illinois Glass Co.).

Extruder with Jointed Feed Screw. No. 2,946,089. E. E. Heston, Akron, O. (to National Rubber Machinery Co., Akron, O.).

Apparatus for Rotationally Distributing a Liquid Charge Within a Mold. No. 2,946,092. A. F. Yoder, Sandusky, O. (to Barr Rubber Products Co., Sandusky, O.).

Feeding Mechanism for Extruders. No. 2,947,030. C. F. Varn, W. New Brighton, N. Y. (to U. S. Rubber Co., New York, N. Y.).

Apparatus for Processing Extruded Plastic Tube. No. 2,947,032. C. W. Taylor, Jr., Akron, O. (to Goodyear Tire & Rubber Co., Akron, O.).

Article Abstracts

Materials

"Polyethylene Scrap a Problem?" Gerald Bamberger, MODERN PLASTICS, 37, 8, 114 (April 1960).

A low-cost system is described for pelletizing film.

"Determination of the Effect of Annealing on Residual Molding Stresses," L. B. Allen, SPE J., 16, 7, 713 (July 1960).

A test method that enables calculation of residual stress, in psi.

"The Determination of Thermal Stability of Vinyl Chloride Polymers and Copolymers Using the Discoloration Method," B. Schmitt and R. Breu, KUNSTSTOFFE, 50, 8, 431 (Aug. 1960).

A report on the suggestion made by ISO/TC 61 to modify the Draft Recommendation ISO 217, including the evaluation of tests carried out in this connection. These investigations are based on work carried out by BASF. The modification suggested was accepted at the Munich conference of ISO/TC, and has led to the creation of the German Draft Standards.

"New Epoxy Molding Compounds," P. E. Fina, SPE J., 16, 7, 722 (July 1960).

Properties of the new compounds are given to show their usefulness in industry.

"Creep Characteristics of Compression-Molded Polyethylene," G. R. Gohn and J. D. Cummings, ASTM BULL., No. 247, pp. 64 (July 1960).

Extension - time curves are given showing the creep characteristics of the compounds at various stresses ranging from 50-800 psi. for continuous loading periods of 95,000 hrs. Compatative curves for a current product are also shown for a periods of 95,000 hrs. Comparative curves times in excess of 40,000 hrs. are required to establish constant creep rates at all but the lowest test stresses.

"Copolymers of Methylmethacrylate and Styrene for Molding and Extrusion," T. E. Davies, BRIT. PLASTICS, 33, 5, 195 (May 1960).

As the result of recent work on light stabilizers and on polymerization processes and modifications, copolymers of methylmethacrylate and styrene capable of meeting requirements previously satisfied only by polymethylmethacrylate have been developed. A copolymer with approximately 60% methylmethacrylate has proved to be very suitable for many acrylic-type applications.

Equipment

"New Aspects of Plastics Pipe Extrusion," H. Domininghaus and Schiedrum, PLASTICS (LONDON), 25, 278, 497 (Dec. 1960).

A discussion of extruder coponents and their design for making pipe.

"Split Injection Mold with Double Ejection," H. Gastrow, KUNSTSTOFFE, 50, 12, 727 (Dec. 1960).

Discussion of the subject molds.

Applications

"The Future for Silicones," J. M. Cunningham, APPLIED PLASTICS, 3, 10, 24 (Oct. 1960).

A brief review of applications for Silicone plastics.

"Ultraviolet Absorbers give New Plastics Applications," J. A. Weicksel, APPLIED PLASTICS, 3, 12, 42 (Dec. 1960).

Report on new U-V absorbers which are expected to solve problems associated with degradation of polyolefins due to weather action.

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in May. The last listing appeared in the January issue.

Egan EXTRUDERS
★ AIR COOLED
★ DIRECT ELECTRIC HEAT
★ WILLERT TEMPERATURE CONTROL SYSTEM
Available in sizes: 2" through 12"
with complete line of accessories
FRANK W. EGAN & COMPANY
SOMERVILLE, NEW JERSEY CABLE ADDRESS: EGANCO—SOMERVILLE, NJER
MANUFACTURERS OF PROCESSING MACHINERY FOR PAPER, FILM & FOIL, AIR DRYING SYSTEMS; ROTOGRAVURE PRINTING PRESSES; PLASTICS EXTRUDERS & ACCESSORIES; TEXTILE FINISHING MACHINERY.

"Polyesters as Corrosion-Resistant Coatings," L. Graubart, SPE J., 16, 12, 1317 (Dec. 1960).

The importance of formulation, application, and testing of new heavy-duty coatings for indoor, outdoor, and corrosive chemical environments is described.

"Predicting the Endurance of Pressurized Polythene Pipe," W. A. Dukes, BRIT. PLASTICS, 33, 12, 575 (Dec. 1960).

Early test results indicate that ambient temperatures permit the prediction of long-term results.

"The Chemistry and Application of Rug-Backing Compounds," George Brawner, AUSTRAL. PLASTICS & RUBBER, 16, 182, 23 (Aug. 1960).

A review of natural and synthetic rug-backing compounds.

"Applied Silicone Insulation," K. D. Rowlands, APPLIED PLASTICS, 3, 10, 30 (Oct. 1960).

A review of silicone electrical insulating materials and their uses.

"Plastics for Atom Smashers," J. O. Turner, MATERIALS DESIGN ENG., 52, 5, 132 (Nov. 1960).

The plastics components in the accelerator and its supporting apparatus are described.

"New Polymers and New Methods Boost Plastics for Automotive Use," J. H. DuBois, INDIAN PLASTICS REVIEW, No. 8, 17 (Aug. 1960).

A brief mention of developments in blow molding potting compounds, phenolic materials, and other classes of materials.

"New Plastics for Cars," Herman Mark, APPLIED PLASTICS, 2, 10, 20 (Oct. 1960).

A brief review of recent developments.

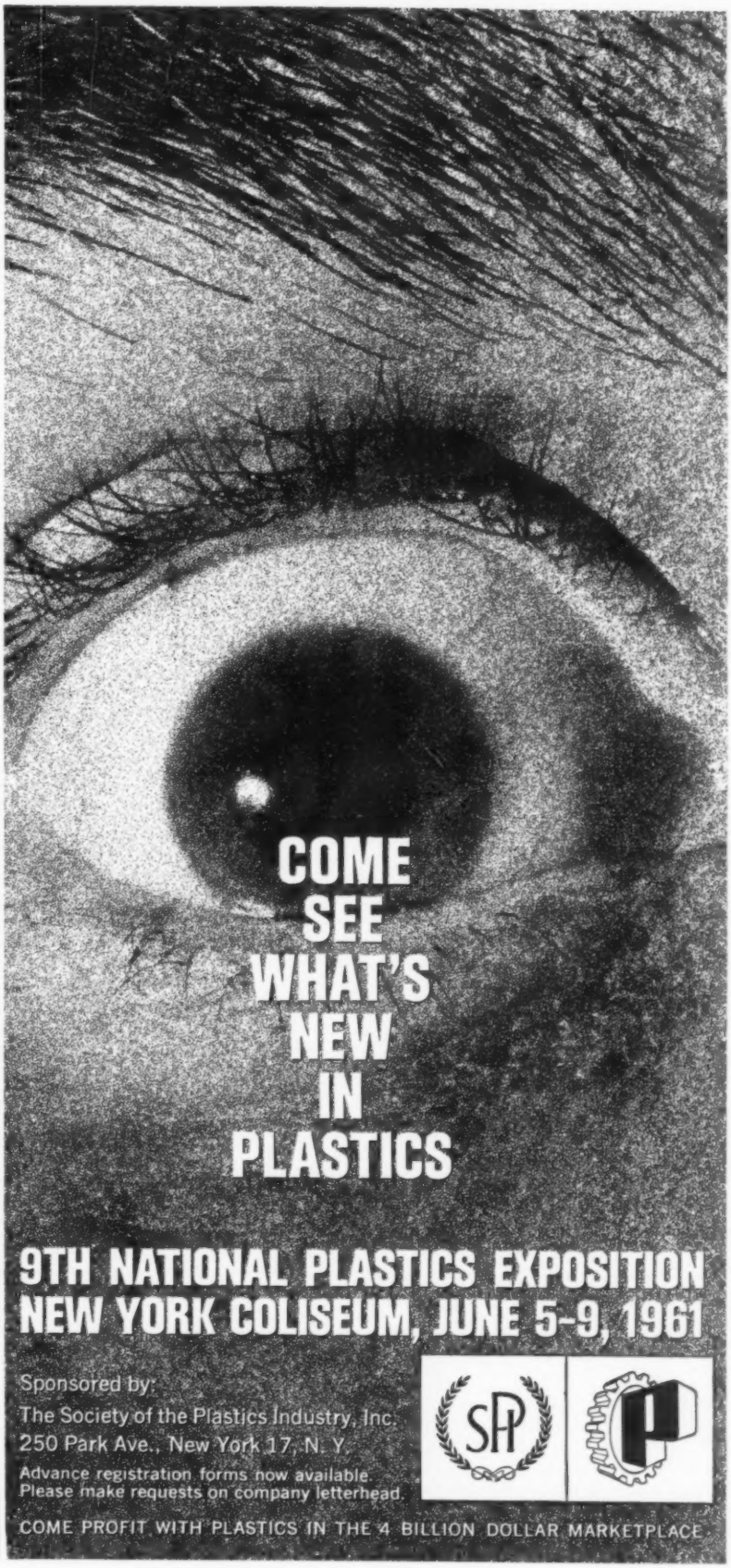
General

"Standardization in the Plastics Field," T. Bronchi, POLIPLASTI, 8, 41, 19 (July-Aug., 1960).

The history of the development of standards for plastics materials and products in Italy is reviewed from the first steps taken in this direction in 1940 to the latest specifications issued on rigid PVC pipe, in April 1960. (In Italian.)

"Injection Molding Plant Lay-out," E. Adolf, PLASTE U. KAUTSCHUK, 7, 7, 329 (July 1960).

The layout is considered in detail of a modern injection molding plant to be set up in a section of a large plastics factory in Schwerim. There will be 100 injection machines and 300 persons will be employed. (In German.)



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6 times	$21.00 per inch
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102 Grove Street, Worcester, Mass. Pleasant 7-7747

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102 Grove Street, Worcester, Mass. PLeasant 7-7747

Six to Eight Inch Extruder Wanted, 20 to 1 ratio or longer. Must be in first class condition with variable speed motor. Screw, die, and heating system must be suitable for pelletizing polyethylene and polystyrene.

Box #65
PLASTICS TECHNOLOGY
630 Third Avenue New York 17, N.Y.

CALENDAR of COMING EVENTS

March 21-30
American Chemical Society. National Meeting. St. Louis, Mo.

March 22-24
Rubber & Plastic Adhesive & Sealant Manufacturers Council. Hollywood-Roosevelt Hotel, Hollywood, Calif.

March 28
Building Research Institute Plastics Study Group. New York, N. Y.

April 4-5
SPE Pioneer Valley Section RETEC. Plastics Injection Molding Workshop. Holy Cross College, Worcester, Mass.

April 20
SPE Western New England Section RETEC. Plastics—A New Dimension in Buildings. Springfield Museum of Art, Springfield, Mass.

April 20-21
SPE Eighteenth Annual Western Section Conference. Hotel del Coronado, Coronado, Calif.

May 9
SPE Detroit Section RETEC. Plastics in the Automotive Industry. Detroit, Mich.

May 16-18
Building Research Institute 1961 Spring Conferences, Shoreham Hotel, Washington, D. C.

May 22
ASME Design Engineering Conference and Show. Cobo Hall, Detroit, Mich.

June 5-9
SPE National Plastics Conference. Commodore Hotel, New York, N. Y.

June 5-9
SPI Ninth National Plastics Exposition. Coliseum, New York, N. Y.

June 11-15
ASME Summer Annual Meeting. Statler Hilton, Detroit, Mich.

June 14
SPE Quebec Section RETEC. Plastics in Packaging. Montreal, Quebec, Canada.

June 15-16
Purdue University, SPI, and American Society of Tool and Mfg. Engineers. Annual Plastics for Tooling Seminar. Purdue University, Lafayette, Ind.

June 16-25
Europlastic 61. International Plastics Exhibition. Palais des Floralies, Ghent, Belgium.

June 19-20
Plastics Institute. Education and Training in the Plastics Industry. Institution of Electrical Engineers, Savoy Place, London W.C. 2, England.

June 25-30
ASTM Annual Meeting. Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

July 3-7
Gordon Research Conferences. Polymers. Colby Junior College, New London, N. H.

July 17-21
Gordon Research Conferences. Elastomers. Colby Junior College, New London, N. H.

Abstracts of Important Articles (Cont'd.)

"Progress of Plastics in Relation to Basic Materials and Outlets," M. Jacque, PENSEZ PLASTIQUES, No. 87, pg. 97, (Sept. 1960).

The plastics industry in the chief European countries and Japan has more than made up set-backs suffered during the war, and progress there is now at a more rapid rate than in the United States. Concentrating chiefly on France, the author deals with the main factors in this advance, primary materials, the chief plastics produced, and prospects. (In French.)

"The Role of Plastics in Textiles and Leather. Patents from 1942-1955," MATIERES PLASTIQUES, 7, 74, 729 (Oct. 1960).

The patents, registered in France, cover synthetic fibers; plastics used in dyeing, printing, and decorating fabrics; dressings and finishes, and proofing for the textile industry; artificial leathers, felts; garments and accessories; footwear; plastics in tanning; and in equipment for spinning and weaving. (In French.)

"The Petrochemical Industry," M. Moulin, M. Febvay and G. M. Pascal, IND. PLASTIQUES MOD., 12, 9, 3 (Nov. 1960).

In connection with a visit to their installations, organized by two big French refineries, three papers were read: (1). reviewed the development of petrochemistry in the United States and Europe and gave details for France on resources in oil and natural gas; and productive capacity of basic hydrocarbons, and output of their chemical derivatives; (2). described operations of the Compagnie Française de Raffinge and associated plastics concerns at Gonfreville; and (3). similarly dealt with the petrochemical complex at Port-Jerome where Société Français Esso-Standard and associated companies produce basic and intermediate materials, as well as synthetic rubber, polyethylene, and polypropylene. (In French.)

Domestic Production and Sales of Plastics and Resin Material, October and November, 1960

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of October and November, 1960. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

	October, 1960		November, 1960	
	Production	Sales	Production	Sales
Cellulose Plastics:				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,613,735	1,577,843	1,389,724	1,538,483
Sheets, 0.003 gage and over	1,969,819	1,879,845	1,891,955	1,872,042
All other sheets, rods, and tubes (including other cellulose plastics)	823,144	1,003,428	791,455	824,082
Molding and extrusion materials (including other cellulose plastics)	7,109,351	7,526,064	7,123,652	6,361,736
Nitrocellulose sheets, rods, and tubes	72,495	88,636	85,176	97,089
TOTAL	11,588,544	12,075,816	11,281,962	10,693,412
Phenolic and Other Tar-Acid Resins:				
Molding materials	16,406,949	16,713,559	15,445,208	13,338,403
Bonding and adhesive resins for—				
Laminating (except plywood)	5,473,682	3,794,398	5,337,054	3,413,939
Coated and bonded abrasives	1,069,893	961,584	1,136,060	973,929
Friction materials (brake linings, clutch facings, and similar materials)	1,240,990	1,026,939	1,039,181	772,327
Thermal insulation (fiber glass, rock wool)	4,343,732	4,276,125	3,859,762	3,823,885
Plywood	4,300,960	3,282,432	4,189,051	3,487,596
All other bonding and adhesive uses	5,900,906	5,546,185	5,700,625	5,409,869
Protective-coating resins unmodified and modified except by rosin	1,582,437	1,317,660	1,914,396	1,474,380
Resins for all other uses	3,788,689	3,422,846	3,317,784	2,777,560
TOTAL	44,108,238	40,341,728	41,939,121	35,471,888
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,321,707	2,288,531	2,450,515	2,286,189
Paper-treating and paper-coating resins	1,844,562	1,863,102	1,999,196	1,739,779
Bonding and adhesive resins for—				
Laminating	3,214,285	2,446,806	2,718,599	2,137,709
Plywood	7,251,552	6,939,621	7,553,303	7,057,068
All other bonding and adhesive uses	3,037,315	2,490,740	2,391,172	2,327,621
Protective-coating resins, straight and modified	3,437,558	2,248,063	2,935,116	1,764,342
Resins for all other uses, including molding	9,614,349	9,986,722	8,813,049	9,153,496
TOTAL	30,721,328	28,263,585	28,860,951	26,465,204
Styrene Resins:				
Molding and extrusion materials:				
Straight polystyrene	26,089,464	22,661,421	25,552,042	20,009,440
All other	30,173,426	25,271,705	29,131,017	24,073,992
Protective-coatings	5,491,501	5,170,111	6,327,834	5,019,536
Textile and paper treating and coating resins	6,618,446	4,588,530	6,083,281	4,838,120
All other uses	13,270,258	17,726,179	13,211,240	17,884,166
TOTAL	81,643,095	75,417,946	80,305,414	71,825,254
Vinyl and Vinyl Chloride Resins:				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—		9,175,730		7,351,076
Film (resin content)		11,109,097		10,830,050
Sheeting (resin content)		25,489,865		25,458,939
Molding and extrusion (resin content)		5,174,867		4,615,328
Flooring (resin content)		15,194,336		14,003,989
Protective coating (resin content)		2,887,167		2,872,945
All other uses (resin content)		11,304,297		9,784,208
All other vinyl resins for—				
Adhesives (resin content)		5,087,145		4,750,784
Protective coatings (resin content)		1,771,376		2,620,159
All other uses (resin content)		10,620,071		10,224,773
TOTAL	104,584,095	97,813,951	98,006,942	92,512,251
Coumarone-Indene and Petroleum Polymer Resins	19,170,694	19,002,131	17,916,411	17,606,739
Polyester Resins:				
For reinforced plastics	9,857,930	7,956,615	9,211,049	8,040,143
For all other uses	2,270,204	1,822,673	1,985,161	2,125,562
TOTAL	12,128,134	9,779,288	11,196,210	10,165,705
Polyethylene Resins:				
For film and sheeting		37,767,225		37,062,652
Molding materials		15,319,486		14,009,800
Extrusion materials		14,578,468		13,296,141
For all other uses		40,427,535		46,377,422
TOTAL	112,885,966	108,092,714	114,135,458[1]	110,746,015[2]
Epoxy Resins:				
For protective coatings		1,510,876		1,539,343
For all other uses		2,598,429		2,282,408
TOTAL	5,747,666	4,109,305	4,281,576	3,821,751
Silicone Resins	394,307	377,262	545,422	349,263
Miscellaneous Synthetic Plastics and Resin Materials	26,886,058	21,397,288	25,622,333	21,384,314
GRAND TOTALS	449,858,125	416,671,004	434,091,827	401,041,796

[1] 16.5% produced by the low-pressure process.
[2] 13.3% produced by the low-pressure process.
SOURCE: United States Tariff Commission, Chemical Division.

Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear regularly, while intervening issues will carry a brief tabulation of price changes and additions.

Suppliers whose products do not appear are invited to submit their price data for inclusion in the published listing, as well as any price changes and additions promptly as they occur in order to assure maximum accuracy and value of the listing.

As can be seen, trade names or other company-originated names do not appear in the published tabulation. Products are grouped under their chemical names or chemical types. Any new products to be added to the list should also be so identified by the supplier firm. With the published listing, any questions on prices for specific products should be referred to us. We, in turn, can inform you of the suppliers whose product prices are included in our published listing and, similarly, refer these requests directly to the appropriate supplier(s).

Prices in general are f.o.b. works. Ranges indicates variations in grade, quality, quantities, and geographical locations of customers. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

Adhesives

Chloroprene type	gal.	$1.50 / $1.60
Epoxy type	lb.	1.33 / 2.00
Silicone type	lb.	1.64 / 10.80
Thiocyanate type	lb.	.1725/ .20

Catalysts

Ammonium thiocyanate	lb.	.1725/ .26
Peroxide, acetyl, 25% in DMP	lb.	1.75 / 4.00
Benzoyl, dry, 96%	lb.	.88 / 2.00
Wet, 50% paste in TCP	lb.	.89 / 2.25
In silicone fluid	lb.	2.75 / 4.25
In BBP	lb.	3.00 / 4.25
Caprylyl, liquid, 50% in mineral oil	lb.	4.45 / 5.00
In DOP	lb.	5.00
Cyclohexanone, 45% paste in DBP	lb.	3.00 / 4.00
Powder, 85%, in DBP	lb.	2.00 / 3.00
p-Cyclobenzoyl, paste, 50%		
In mineral oil	lb.	4.25 / 5.00
In TCP	lb.	5.00
2,4-Dichlorobenzoyl, 50%		
In silicone oil	lb.	4.25 / 5.00
40% in silicone oil	lb.	5.00
Di-t-butyl	lb.	2.00 / 4.00
Other peroxides	lb.	2.05 / 5.00

Colorants

Black, std.	lb.	.90 / 4.10
Gel coats	lb.	.61 / .86
Carbon black	lb.	.0575/ .87
Paste	lb.	.65 / .74
Bone blacks	lb.	.175 / .2775
Iron oxide	lb.	.15 / .23
Lampblack	lb.	.1225/ .175
Masterbatch	lb.	.60 / .63
Paste (for epoxies)	lb.	1.58 / 2.15
Paste dispersion	lb.	.85 / 1.90
Paste concentrate	lb.	.82 / 1.20
Pigment dispersion	lb.	.83 / 1.15
Colloidal dispersions	lb.	.66 / 1.45
Aqueous	lb.	.115 / .395
Blue, std.	lb.	.90 / 2.75
Concentrate	lb.	.95 / 3.00
Masterbatch	lb.	.85 / 1.13
Pearl	lb.	1.38
Metallic	lb.	.02
Paste (for epoxies)	lb.	1.25 / 2.60
Paste dispersion	lb.	.85 / 2.40
Paste concentrate	lb.	.78 / .80
Phosporescent	lb.	.24
Brown, std.	lb.	.87 / 4.00
Copper tinsel	lb.	.10
Gel costs	lb.	.59 / 1.04
Iron oxide	lb.	.15 / .24
Metallic bronze	lb.	.02
Paste (for epoxies)	lb.	1.18 / 1.47
Paste dispersions	lb.	.75 / 1.70
Paste concentrate	lb.	.65 / 2.30
Gold, metallic	lb.	.21
Paste dispersions	lb.	1.40 / 1.60
Tinsels	lb.	.10
Gray, gel coat	lb.	.59 / .84
Paste (for epoxies)	lb.	1.40
Paste dispersion	lb.	1.45 / 2.20
Green, std.	lb.	.90 / 3.25
Pearl	lb.	.10
Concentrate	lb.	.95 / 3.00
Metallic	lb.	.21
Phosphorescent	lb.	.24
Masterbatch	lb.	1.20 / 1.23
Paste (for epoxies)	lb.	2.86
Paste dispersions	lb.	.85 / 2.70
Paste concentrate	lb.	.80 / 2.15
Chromic oxide	lb.	.45 / 1.40
Orange, dry	lb.	.49 / 3.50
Gel coat	lb.	.75 / 1.05
Paste (for epoxies)	lb.	1.58
Paste dispersion	lb.	.55 / 2.80
Paste concentrate	lb.	1.58
Purple, pearl	lb.	.10
Red, std.	lb.	.1425/ 5.00
Concentrate	lb.	2.25 / 2.50
Iron oxide	lb.	.0475/ .205
Metallic	lb.	.021
Masterbatch	lb.	.75 / .88
Paste (for epoxies)	lb.	2.35 / 3.77
Paste dispersions	lb.	.90 / 3.05
Paste concentrate	lb.	5.42 / 6.49
Venetian	lb.	.065 / .1325
Silver, metallic	lb.	.0165
Paste (for epoxies)	lb.	1.55
Paste dispersion	lb.	.85 / 1.45
Paste concentrate	lb.	1.02
Tinsels	lb.	.10
Yellow, std.	lb.	.12 / 3.50
Gel coat	lb.	.61 / 1.03
Masterbatch	lb.	.90 / .93
Concentrate	lb.	1.00 / 2.50
Iron oxide	lb.	.1225/ .1875
Paste (for epoxies)	lb.	2.15 / 2.55
Paste dispersions	lb.	.90 / 2.20
Paste concentrate	lb.	.65 / 2.87
White, std.	lb.	.54 / 4.00
Concentrate	lb.	.70 / 1.25
Gel coat	lb.	.59 / .84
Masterbatch	lb.	.75 / .80
Pearl	lb.	.10
Paste (for epoxies)	lb.	1.02
Paste dispersion	lb.	.70 / 2.00
Paste concentrate	lb.	.705 / .725

Fillers

Aluminum silicate pigments	ton	21.50 / 65.00
Barytes	ton	60.00 / 123.00
Paste concentrate	lb.	.705 / .725
Calcium carbonate, ppt.	ton	55.00 / 75.00
Std.	ton	14.00 / 35.00
China clay	ton	40.00
Flours	ton	50.00 / 106.00
Flocks, cotton	lb.	.12 / .30
Rayon	lb.	.50 / 1.25
Nylon	lb.	.35 / 2.75
Mica	lb.	.075 / 4.44
Silica	ton	25.00 / 48.50
Whiting	ton	8.75 / 13.25
Wollastonite	ton	29.00 / 47.50

Miscellaneous

Anti-Fog	gal.	8.69 / 16.95
Anti-Static	gal.	3.57 / 8.50
Purging cmpd. (for injection)	lb.	.40
Wetting agent (for dry coloring)	gal.	2.50 / 3.20

Mold Release Agents

Silicone type: Cmpds	lb.	4.70 / 5.15
Emulsions	lb.	1.11 / 1.65
Fluids	lb.	2.78 / 6.00
Solvent emulsions	lb.	1.74 / 4.95
Stearates: Barium	lb.	.41 / .46
Calcium	lb.	.39 / .44
Magnesium	lb.	.42 / .47
Zinc	lb.	.41 / .48

Plasticizers

Adipate, Butyl Cellosolve	lb.	.45 / .47
Didecyl	lb.	.265
Dibutoxyethyl	lb.	.425 / .46
Diisodecyl	lb.	.40 / .44
Diisobutyl	lb.	.41 / .44
Dioctyl	lb.	.40 / .535
Diisooctyl	lb.	.40 / .435
2-ethyl hexyl	lb.	.40 / .44
Isooctylisodecyl	lb.	.40 / .435
Isooctyl	lb.	.49 / .535
n-Octyl decyl	lb.	.40 / .44
Azelate, dioctyl	lb.	.445 / .49
Epoxy, polymeric	lb.	.3225/ .3525
Monomeric	lb.	.3475/ .3775
Ester, Fatty Acid	lb.	.3525/ .3775
Monomeric	lb.	.35 / .60
Oleate, Butyl	lb.	.24 / .42
Phosphate, Tributyl	lb.	.50 / .535
Tricresyl	lb.	.325 / .36
Phthalate, Butyl Cellosolve	lb.	.35 / .385
Butyl octyl	lb.	.255 / .30
Cyclohexyl	lb.	.265 / .305
Isodecyl	lb.	.26 / .30
Dibutyl	lb.	.285 / .43
Dicapryl	lb.	.265 / .445
Dicyclohexyl	lb.	.465 / .495
Didecyl	lb.	.265 /
Diisodecyl	lb.	.265 .45
Diisooctyl	lb.	.26 / .445
Dioctyl	lb.	.265 / .305
Isooctyldecyl	lb.	.27 / .45
Polyester type	lb.	.385 / .7125
Polymeric type	lb.	.39 / .93
High-solvating	lb.	.37 / .425
Ricinoleate type	lb.	.32 / .35
Sebacate, Dibenzyl	lb.	.91 / 1.04
Dibutyl	lb.	.655 / .745
Dioctyl	lb.	.5925/ .6825
Soy Bean oil, epoxized	lb.	.3235/ .4775
Stearate, Butyl	lb.	.2225/ .3825
Epoxized octyl	lb.	.3475/ .5325
Octyl epoxy	lb.	.3925/ .4475
Tallate, Octyl epoxy	lb.	.3475/ 4.025

Resins, Molding, Casting & Coating

ABS type	lb.	.45 / .56
Acrylic	lb.	.46 / 1.08
Alkyd	lb.	.1325/ .137
Allyl (diallyl phthalate)	lb.	.95 / 3.20
Carbonate	lb.	1.30 / 2.25
Cellulosics:		
Cellulose acetate	lb.	.35 / .68
Reprocessed	lb.	.25 / .36
Cellulose acetate-butyrate	lb.	.40 / .81
Reprocessed	lb.	.35 / .45
Cellulose propionate	lb.	.40 / .81
Ethyl cellulose	lb.	.67
Reprocessed	lb.	.30
Epoxy, liquid	lb.	.60 / 1.41
Solid	lb.	.51 / 1.31
Fluorocarbons	lb.	9.75
Furane	lb.	.75 / 1.00
Liquid	lb.	.32 / .44
Melamine coating solns	lb.	.3275/ .4375
Phenolic	lb.	.207 / .7175
Coating solns	lb.	.305 / .3525
Polyamide	lb.	.98 / 1.85
Graphite-filled	lb.	1.40 / 1.83
Heat-stabilized	lb.	1.09 / 1.55
Molybdenum sulfide-filled	lb.	1.19 / 2.10
Polyester, powder	lb.	.26 / .545
Coating	lb.	.0975/ .1275
Polyethylene, low-density	lb.	.2375/ .615
Medium-density	lb.	.2375/ .6425
High-density	lb.	.275 / 1.29
Polypropylene	lb.	.42 / .68
Reprocessed	lb.	.50
Polystyrene	lb.	.18 / 1.34
Reprocessed	lb.	.15 / .26
Polyurethane	lb.	1.30 / 7.50
Silicones, casting	lb.	7.50 / 11.40
Molding	lb.	2.40 / 3.55
Urea coating solns	lb.	.205 / .27
Vinyl, dispersion grade	lb.	.24 / .325
Molding	lb.	.185 / .66
Nitrile rubber blend	lb.	.45 / .53
Reprocessed	lb.	.19 / .22
Vinylidene	lb.	.205 / .32
Latex	lb.	.45 / .52

Solvents

Ketones: Acetate	lb.	.08 / .22
Methyl isoamyl	lb.	.175 / .315
Esters: Ethyl acetate	lb.	.125 / .2675
Isopropyl acetate	lb.	.115 / .255
n-Butyl acetate	lb.	.145 / .285
Alcohols: Isobutyl	lb.	.13 / .27
n-Butyl	lb.	.155 / .295

Stabilizers

Alkyd tin mercaptide, liquid	lb.	2.50 / 3.15
Barium-cadmium complex, liquid	lb.	.50 / .585
Solid	lb.	.97 / 1.25
Barium-cadmium laurate	lb.	.87 / .90
Myristate	lb.	.72 / .75
Barium-cadmium-zinc complex	lb.	.54 / .56
Barium-zinc, liquid	lb.	.58 / .615
Powder	lb.	.375 / .44
Complex	lb.	.47 / .50
Cadmium-barium, powder	lb.	.68 / .895
Chelating agent, liquid	lb.	.57 / .84
Cadmium-containing	lb.	.84 / .87
Zinc-containing	lb.	.62 / .80
Organic complex, liquid	lb.	.57 / .845
Strontium-zinc laurate	lb.	.72 / .75
Zinc, liquid	lb.	.48 / .52

***Translation: For low temperature applications, depend on Pittsburgh ADIPATE Plasticizers.** Pittsburgh Adipates are available as esters of n-octyl n-decyl, 2-ethylhexyl, iso-decyl and iso-octyl alcohols . . . designed to meet your exacting low temperature flexibility requirements. *Whatever* your plasticizer needs, call on Pittsburgh Chemical, a company that takes pride in its ability to provide uniform, high purity products . . . delivered on schedule . . . backed with competent technical "know-how." 2749

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10 BRIGHT COLORS

for industrial finishes...plastics

exceptionally heat stable—excellent permanence—exceedingly easy to disperse

CADMIUM RED PIGMENTS

Cadmium Lithopones

Orange Red No. 70
Light Red No. 80
Medium Light Red No. 90
Medium Red No. 100
Dark Red No. 110
Maroon No. 120

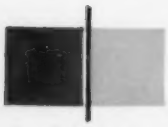
BLEED PROOF

CADMIUM YELLOW PIGMENTS

Cadmium Lithopones

Primrose No. 20
Lemon No. 30
Golden No. 40
Orange No. 50

BLEED PROOF



SAMPLES AND COLOR FOLDER showing full range of Yellows and Reds, CP and Lithopone, will be gladly furnished on request

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